BRI
1526

Presented by

The British Association

for the Advancement of Science.

6206.

RE-BOUND 1938

Alex. Agassiz.

Library of the Museum

OF

COMPARATIVE ZOÖLOGY,

AT HARVARD COLLEGE, CAMBRIDGE, MASS.

Founded by private subscription, in 1861.

Deposited by Alex. Agassiz
from the Library of LOUIS AGASSIZ.

No. 6206

REPORT

OF THE

TWENTY-FOURTH MEETING

OF THE

BRITISH ASSOCIATION

FOR THE

ADVANCEMENT OF SCIENCE;

HELD AT LIVERPOOL IN SEPTEMBER 1854.

LONDON:
JOHN MURRAY, ALBEMARLE STREET.
1855.

PRINTED BY
RICHARD TAYLOR AND WILLIAM FRANCIS,
RED LION COURT, FLEET STREET.

6206

CONTENTS.

Page

Objects and Rules of the Association xv

Places of Meeting and Officers from commencement xviii

Table of Council from commencement xxi

Treasurer's Account xxiii

Officers and Council xxiv

Officers of Sectional Committees xxv

Corresponding Members... xxvi

Report of the Council to the General Committee xxvi

Report of the Kew Committee xxvii

Report of the Parliamentary Committee xlii

Recommendations for Additional Reports and Researches in Science xlvi

Synopsis of Money Grants xlix

General Statement of Sums paid for Scientific Purposes l

Extracts from Resolutions of the General Committee liv

Arrangement of the General Meetings liv

Address of the President... lv

REPORTS OF RESEARCHES IN SCIENCE.

Third Report on the Facts of Earthquake Phænomena. Catalogue of recorded Earthquakes from 1606 B.C. to A.D. 1850 (continued). By Robert Mallet, C.E., F.R.S., M.R.I.A. 1

On the Construction and general Use of Efficient Life-Boats. By Major-General Chesney, R.A., D.C.L., F.R.S. &c. 327

A Third Report (supplementary to two former Reports made to the British Association 1832 and 1840) on the present state of our knowledge of Radiant Heat. By the Rev. Baden Powell, M.A., F.R.S., F.R.A.S., F.G.S., Savilian Professor of Geometry in the University of Oxford 337

Page

On some of the results obtained at the British Colonial Magnetic Observatories. By Colonel EDWARD SABINE, R.A., Treas. & V.P.R.S., General Secretary........ 355

Report of the Committee on Earthquakes, with their Proceedings respecting Seismometers constructed under the superintendence of Major James, R.E. By Colonel PORTLOCK, R.E., F.R.S........ 370

On the Influence of the Solar Radiations on the Vital Powers of Plants growing under different Atmospheric Conditions.—Part II. By J. H. GLADSTONE, Ph.D., F.R.S........ 373

Report on Observations of Luminous Meteors, 1853–54. By the Rev. BADEN POWELL, M.A., V.P.R.S. &c., Savilian Professor of Geometry in the University of Oxford........ 386

Second Report of the Committee, consisting of the EARL OF ROSSE, the Rev. Dr. ROBINSON, and Professor PHILLIPS, appointed by the General Committee at Belfast, to draw up a Report on the Physical Character of the Moon's Surface, as compared with that of the Earth... 415

On the Application of Water-pressure Machinery. By W. G. ARMSTRONG, F.R.S........ 417

On the Equivalency of Starch and Sugar in Food. By J. B. LAWES, F.R.S., F.C.S.; and J. H. GILBERT, Ph.D., F.C.S. 421

On the Deviations of the Compass in Wooden and Iron Ships. By ARCHIBALD SMITH, M.A. 434

Thirteenth Report of a Committee, consisting of Professor DAUBENY, Professor HENSLOW, and Professor LINDLEY, appointed to continue their Experiments on the Growth and Vitality of Seeds 439

NOTICES AND ABSTRACTS

OF

MISCELLANEOUS COMMUNICATIONS TO THE SECTIONS.

MATHEMATICS AND PHYSICS.

MATHEMATICS.

Page
Mr. ARTHUR CAYLEY on the Solution of Cubic and Biquadratic Equations ... 1
Sir W. R. HAMILTON on an Extension of Quaternions 1

LIGHT, HEAT, ELECTRICITY, MAGNETISM.

M. BABINET on a New Photometer 2
Dr. FÉLIX BERNARD'S Note on Indices of the Refraction of Transparent Media included between two Parallel Faces, and on a Portable Refractometer, exhibited to the British Association for the Advancement of Science 2
——————— Description of a Photometer exhibited to the British Association for the Advancement of Science 4
——————— Note on Polarimetry.. 5
Mr. JOHN W. BRETT on the Origin of the Submarine Telegraph and its Extension to India and America 7
Mr. EDWARD B. BRIGHT on Magneto-Electricity and Underground Wires ... 8
M. DOVE on an Apparatus for elliptically-polarized Light 9
——— on some Stereoscopic Phænomena 9
——— on a Method of measuring the Absorption of Polarized Light in doubly refracting Crystals 10
Rev. J. B. READE on Photographs of the Moon and of the Sun 10
Sir JOHN ROSS on Errors which may be occasioned by disregarding the Influence of Solar or Artificial Light on Magnets 12
——————— on the Deviation of the Magnetic Needle peculiar to Liverpool 12
Rev. Dr. SCORESBY on Pictorial and Photochromatic Impressions on the Retina of the Human Eye 12
Mr. ARCHIBALD SMITH on a Graphic Method of Correcting the Deviations of a Ship's Compass 13

Page

Professor W. THOMSON's Account of Experimental Researches in Thermo-Electricity 13

Professor TYNDALL on the Diamagnetic Force 14

Mr. C. F. VARLEY on Improvements in Submarine and Subterranean Telegraph Communications 17

Captain WARD's Notice of some Experimental Researches into the Application of the Voltaic Battery to the Ignition of Gunpowder 18

ASTRONOMY.

M. CHACORNAC's New Observations on Solar Spots and Fæculæ, and their true Causes 19

Mr. GREG on Meteorolites and Asteroids 19

Mr. JOHN HARTNUP on the Variation in the Rates of Chronometers 20

Mr. W. S. JACOB's Notes on the British Association Catalogue of Stars 25

Mr. JOHN PHILLIPS on Micrometrical and Photographic Drawings of the Lunar Surface 25

Mr. DANIEL VAUGHAN's Researches in Meteoric Astronomy 26

TIDES.

Rev. Dr. WHEWELL on Mr. Superintendent Bache's Tide Observations 28

METEOROLOGY.

Professor DOVE on the Distribution of Rain in the Temperate Zones 28

Mr. JOHN DREW's continuation of Remarks on the Climate of Southampton... 29

Mr. JAMES GLAISHER on Photogenic Drawings of Snow Crystals, as seen in January 1854 30

Mr. JOHN B. NEVINS's Examination of the Storms which have visited England and Ireland during the years 1852, 1853, and 1854, with reference to the Theory of Rotatory Storms 30

Rev. T. RANKIN on the Meteorology of Huggate, Yorkshire Wolds 34

Colonel SYKES on the Meteorology of Nice Maritime for 1853 34

Mr. H. POOLE on the Meteorology of the Albion Mines, Nova Scotia 35

Mr. W. J. MACQUORN RANKINE on some Simultaneous Observations of Rainfall at Different Points on the same Mountain Range 46

Mr. J. KING WATTS on Auroræ Boreales observed at St. Ives 47

INSTRUMENTS.

Mr. C. BROOKE on an easy Method of making thin Glass Cells for mounting Microscopic Objects in Fluid 47

Dr. JOHN LEE on Photographic Drawings of Meteorological Instruments adopted by the Council of the British Meteorological Society 47

Professor STURM on a Method of Manufacturing Cylindrical Lenses 47

Page
Mr. **Cornelius Varley** on Natural Occurrences that impair the Vision of good Telescopes 48

Navigation.

Rev. Dr. **Scoresby** on the Loss of the 'Tayleur,' and the Changes in the Action of Compasses in Iron Ships 49
———— Inquiry into the Principles and Measures on which Safety in the Navigation of Iron Ships may be reasonably looked for 53
Mr. J. T. **Towson** on the Inefficiency of the Aids of Science at present in connexion with the Compasses of Iron Ships 55

General Physics.

Mr. W. **Fairbairn** on the Density of various Bodies when subjected to enormous compressing Forces 56
M. L. **Foucault**, Nouvelles Expériences sur le Mouvement de la Terre au Moyen du Gyroscope 56
Mr. W. **Hopkins**'s Account of some Experiments on the Effect of Pressure on the Temperature of Fusion of different Substances 57
Mr. W. J. **Macquorn Rankine** on Formulæ for the Maximum Pressure and Latent Heat of Vapours 58
Professor W. **Thomson** on Mechanical Antecedents of Motion, Heat, and Light 59
Mr. **William Petrie** on the Motion of Fluids; a remarkable variation in the great Elementary Law of the ratio between Pressure and Velocity 63
Mr. J. J. **Waterston** on a Method of Computing the Absolute Volume of the Ultimate Particles of Liquids 63

CHEMISTRY.

Professor **Thomas Anderson** on the Constitution of Meconine and Papaverine, and their Relations to the other Constituents of Opium 64
———— on the Alkaloids produced during the Destructive Distillation of Animal Substances 64
Mr. **George Robert Berry** on Collodion Negatives 64
Professor F. **Crace Calvert** on the Physiological Properties of Carbazotic Acid 65
———— on the Action of Gallic and Tannic Acids on Iron and Alumina Mordants 65
———— on the Action of Citric, Tartaric and Oxalic Acids on Cotton and Flax Fibres under the influence of Dry Heat and Pressure of Steam 65
Mr. **Andrew Crosse** on the apparently Mechanical Action accompanying Electric Transfer 66
Mr. J. A. **Davies** on the Decomposition of Magnesian Limestone at Brodsworth 66
Dr. **Edwards** on Collodion Photographs of the Moon's Surface 66

Page

M. Ferrière on Photographs upon Albumen 67

Mr. David Forbes on the Chemical Examination of some Alloys of Copper and Zinc 67

———— on the Occurrence and Chemical Composition of some Minerals from the South of Norway 67

Mr. J. P. Gassiot on the Heating Effects of Secondary Currents 68

Dr. J. H. Gladstone on a Method of Analysis applicable to the Quantitative Estimation of Nitric and Acetic Acids 68

———— On the Fluorescence exhibited by certain Iron and Platinum Salts 68

Professor Graham on the Concentration of Alcohol in Sömmering's Experiments 69

Mr. G. Hamilton on the Results of Experiments on the Preservation of Fresh Meat 69

Mr. Samuel Highley's Hints on the Management of some difficult subjects in the application of Photography to Science 69

———— on the Means of applying Photography to War purposes in the Army and Navy 70

Mr. Henry How on the Hyposulphites of the Organic Alkalies 70

Mr. G. Knight on a Stereoscopic Cosmoramic Lens 70

Mr. J. B. Lawes and Dr. J. H. Gilbert on the Equivalency of Starch and Sugar in Food 70

———— on the Amounts of, and Methods of estimating, Ammonia and Nitric Acid in Rain Water 70

Mr. Stevenson Macadam's Note on the Presence of Lead in Hydrochloric and Nitric Acids 72

———— on the Distribution of Iodine in the Mineral, Vegetable, and Animal Kingdoms 72

———— on the Cause of the Phænomena exhibited by the Geysers of Iceland 73

———— on the Presence of Lead in Hydrochloric and Nitric Acids 74

The Abbé Moigno on the Preservation of Milk 74

Mr. E. C. Nicholson and David S. Price on the Estimation of Iron by the Method of Marguérite, and some Notes on the Preparation of the Standard Solution of Permanganate of Potash 74

Mr. David S. Price on the supposed influence of the Hot-Blast in augmenting the quantity of Phosphorus in Cast Iron 74

Mr. Joseph Spence on the Production of Sulphurous Acid Gas from the Combustion of Coal 75

Mr. W. Symons on a new Electrical Battery 75

Professor J. Tennant on the Re-cutting of the Koh-i-Noor Diamond 75

Mr. James Turnbull on the Physiological Properties of some of the Compounds of the Organic Radicals—Methyle, Ethyle, and Amyle 76

Mr. R. Warington on the Production of Boracic Acid and Ammonia by Volcanic Action 76

———— on the Effect of Coloured Media on the Growth of Red Algæ 77

Page
Mr. G. **Wilson** on the Artificial Preparation of Sea-water for Marine Vivaria 77
Mr. **Francis Wrightson** on the Sewerage of Manufacturing Towns 77

GEOLOGY.

Mr. A. **Bryson** on a curious Structure in the Silurian Slates of Peeblesshire ... 78
Mr. **Robert Chambers** on the Great Terrace of Erosion in Scotland, and its Relative Date and Connexion with Glacial Phænomena.......................... 78
———————— Farther Observations on Glacial Phænomena in Scotland and the North of England 79
Rev. J. G. **Cumming** on some of the more Recent Changes in the Area of the Irish Sea 80
Mr. **John Cunningham** on the Submarine Forest, Leasowe 81
Sir **Philip Egerton** on an Ichthyoid Fossil from India............................ 82
Professor **Ehrenberg** on the Discovery of Microscopic Shells in the Lower Silurian Rocks 82
Professor **Edward Forbes** on the Foliation of some Metamorphic Rocks in Scotland 82
Captain **Garden** and Mr. W. H. **Baily** on the Occurrence of a True Cretaceous Formation in the South of Africa 83
Mr. G. B. **Greenough** on the Geology of India 83
Professor **Harkness** on Crustacean Impressions from the Trias of Dumfriesshire.. 86
———————— on the Anthracite Deposits and Vegetable Remains occurring in the Lower Silurians of the South of Scotland............................ 86
———————— on Mineral Charcoal 86
———————— on Annelid Tracks from the Representatives of the Millstone Grits in the County of Clare 86
Mr. **Edward Hull**'s Abstract of Paper explanatory of a Geological Section, extending from the Island of Little Eye across the Peninsula between the Estuaries of the Dee and Mersey to the East of Liverpool 86
Mr. J. B. **Jukes** on the One-Inch Map of the Northern Part of the County Wicklow, geologically coloured.. 87
Sir **Roderick Impey Murchison**'s General Observations on the Palæozoic Rocks of Germany 87
Mr. **James Nasmyth** on the Structure of Lunar Volcanic Craters 91
Mr. D. **Page** on the Subdivisions of the Palæozoic Rocks of Scotland 91
———— on the Structure and Texture of Stratified Rocks, as a means of determining the Conditions under which they are formed....................... 92
Professor A. C. **Ramsay** on the former probable existence of Palæozoic Glaciers 93
———————— on the thickness of the Ice of the Ancient Glaciers of North Wales, and other points bearing on the Glaciation of the Country... 94
Rev. Professor **Adam Sedgwick** on the May Hill Sandstone, and the Palæozoic System of England.. 95
Professor **John Irwine Whitty** on the Silurian Anthracite of Cavan........ 95

BOTANY AND ZOOLOGY.

BOTANY.

Page

Mr. T. C. ARCHER's Remarks upon some Peculiarities discovered in Liquid Caoutchouc 96

——— on some Materials for making Paper 97

Professor BALFOUR on the Occurrence in Coal of peculiar Vegetable Organisms resembling the Sporangia of Lycopodium 97

Professor GEORGE DICKIE on Associations of Colour and Relations of Colour and Form in Plants 98

Mr. G. LAWSON on the Stipular Glands of Rubiaceæ 99

Rev. Professor J. M'COSH's Observations on the Morphology of Pines and Firs 99

——— some further Observations on the Correspondence between the Leaf-Venation and Ramification of the Plant 100

——— on some Traces of Harmonious Colours in Plants and the Plumage of Birds 101

Mr. F. P. MARRATT on some New Mosses, and on recent Additions to the Muscology of Liverpool 102

Mr. MAXWELL T. MASTERS on the Arrangement of the Air Canals in the Nymphæaceæ (the Water Lilies) 102

Professor REDFERN on the Nature of the Torbanehill and other Varieties of Coal 102

Mr. ROBERT WARINGTON's Account of some Experiments made on the Influence of Coloured Glass on the Growth of Plants in Sea-Water 103

Professor W. C. WILLIAMSON on the Restoration of *Zamites gigas* from the Lower Sandstone and Shale of the Yorkshire Coast 103

Mr. JAMES YATES on *Stangeria Paradoxa* 104

ZOOLOGY.

Professor ALLMAN on the Occurrence in the Infusoria of peculiar Organs resembling Thread-Cells 105

Mr. G. BOWDLER BUCKTON on the Application of Cyanide of Potassium to killing Insects for the Cabinet 106

Mr. ISAAC BYERLY on the Fauna of Liverpool 107

Mr. P. P. CARPENTER's List of Four Hundred and Forty Species of Shells from Mazatlan 107

Professor W. B. CARPENTER on the Development of the Embryo of *Purpura lapillus* 108

Professor E. FORBES on some Points connected with the Natural History of the Azores 108

Mr. T. H. HUXLEY on the Vascular System of the Lower Annulosa 109

Dr. THOMAS INMAN on the Power by which Insects are enabled to adhere to smooth perpendicular Surfaces 109

Page
Dr. THOMAS LAYCOCK on the Physiology of Cells in relation to Consciousness and Adaptive Movements 110
Professor OWEN on the Anthropoid Apes 111
———— on the Anatomy of the Great Ant-eater 113
Mr. ROBERT PATTERSON's Exhibition of Living Sea Animals 113
Mr. J. RICHARDSON on the Medicinal Leech 113
Captain WIDDRINGTON on a supposed New Species of Felis 113
Professor W. C. WILLIAMSON's Remarks on the British Species of Foraminifera 113

MISCELLANEOUS.

Dr. FOWLER on Literary and Philosophical Pursuits as conducive to Longevity 114
Mr. ROBERT WARINGTON's further Memoranda of Observations made in small Aquaria, in which the Balance between the Animal and Vegetable Organisms was permanently maintained 115
Mr. F. WENHAM on the Application of Photography to the Delineation of Microscopic Objects 116

GEOGRAPHY AND ETHNOLOGY.

GEOGRAPHY.

Captain W. ALLEN's Remarks on Levels taken in Jerusalem, with the Aneroid Barometer 116
Mr. J. BOULT on some Sectional Diagrams illustrative of the Changes in the Bed of the River Mersey and its Approaches 117
Mr. J. FERGUSSON on the Site of the Holy Sepulchre at Jerusalem 117
Mr. A. G. FINDLAY on Arctic and Antarctic Currents, and their Connexion with the Fate of Sir John Franklin 117
Despatch from Acting-Consul Gabriel to Lord Clarendon, announcing the arrival of Dr. Livingston at Loanda, on the West Coast of Africa 119
Captain S. GALE on the shortest Routes to South Australia 120
Dr. MATHIE HAMILTON's Remarks on the Lake Aulaga and its Drainage in the Desert of Caranjas, in Bolivia 120
Extracts of a Letter from the Rev. Dr. Livingston to the Rev. Arthur Tidman, D.D., dated Town of Sekelutu, Linyanti, 24th September, 1853 121
Rev. C. G. NICOLAY on the Eastern Territory of the Ecuador and the River Napo 123
Extracts of a Letter from the Rev. J. Rebmann to the Rev. H. Venn, dated Kisaludini (in Rabbai), April 13, 1854 123
Mr. GEORGE RENNIE's Hydrographical Remarks on the Improvement of the Port of Liverpool 124
Mr. D. SEYMOUR on the Caucasus and Parts of the Crimea 124
———— Extracts from the MS. Notes of Travels of General Fevrier in Central Asia, from Teheran to Herat, Balkh, Candahar, and along the course of the Helmund and round the Lake Sistan 125

Page

Communications on an Australian Expedition, from Capt. Charles Sturt, Dr. J. W. F. Blundell, and G. S. Wilson, Geologist to the Expedition 125

Dr. SUTHERLAND on Glaciers in the Arctic Regions 126

Mr. J. TOWSON on Modifications of Great-Circle Sailing 126

Mr. J. B. YATES on the Estuary of the River Mersey, and the hazardous and uncertain Approaches to the Port of Liverpool 126

ETHNOLOGY.

Dr. BLECH on South African Languages 126

Mr. RICHARD CULL's Description of Three Esquimaux, lately exhibited in London 126

——— on the Ethnological Value of the Results of Philological Inquiry 126

Mr. WILLIAM FREUND's Notes on the Etruscan Question 126

Mr. JOSEPH BARNARD DAVIS on the Forms of the Crania of the Ancient Britons.. 127

Rev. ABRAHAM HUME on the Ethnology of the Liverpool District, with Notices of the Hoylake Antiquities 129

Mr. JAMES KENNEDY on the Lost Tribes of Israel 129

Dr. R. G. LATHAM on the non-Russian Populations of Russia in Europe 129

Mr. T. WRIGHT on the Early Ethnology of Britain 130

——— on some Remains of an Early People in the South-eastern corner of Yorkshire 130

STATISTICS.

Mr. HENRY ASHWORTH on the Causes and Consequences of the Preston Strike, 1853 to 1854 130

Mr. T. B. LLOYD BAKER on the Reformation of Offenders........................ 132

Mr. DAVID BUXTON on the Census of the Deaf and Dumb in 1851 132

Mr. JOHN CALVERT on the Supply of Gold from Australia and from English Rocks 133

Rev. JOHN CLAY on the Effect of Good and Bad Times on Committals to Prison 133

Mr. JOHN CLEGHORN on the Fluctuations in the Herring Fisheries 134

Mr. J. T. DANSON on the Current Price and the Cost Price of Corn in England during the last Ten Years, as illustrating the Value of Agricultural Statistics 134

Mr. JACOB A. FRANKLIN on the Decimal Coinage and Accounts, showing the impracticability of the franc or tenpenny unit.................................... 135

Mr. J. W. GILBART on the Laws of the Currency, as exemplified in the Circulation of Country Bank Notes in England since the passing of the Act of 1844... 136

Rev. Dr. HUME on the Education of the Poor in Liverpool........................ 138

Page

Mr. **Charles Jellicoe's** Suggestions for improving the present mode of keeping and stating the National Accounts 138

Mr. **James Knight** on the Rise, Progress, and Present Condition of Joint Stock Banks 138

Dr. R. G. **Latham** on the non-Russian Populations of Russia in Europe 139

Mr. **McNerney's** Statistics of Poor Relief and Movement of Population in the "Commercial District" in the Hundred of Wirral, Cheshire 142

Mr. H. E. **Michel** on the Treatment of abandoned Workings of the Australian Gold Fields 142

Mr. **William Miller** on Decimal Coinage 142

——————— on the Decimalization of the Tariff 143

Mr. **William Newmarch** on the Magnitude and Fluctuation of the Circulation of Bills of Exchange, 1816 to 1853. Statement of some of the results of a further extensive collection of Data 143

——————— Facts and Statements connected with the Question, Whether, in consequence of the Discoveries within the last Six Years, the Exchangeable Value of Gold in this country has fallen below its former level 143

Mr. **Theodore W. Rathbone** on the different Plans which have been proposed of Decimal Accounts and Coinage 143

Colonel **Sykes** on the Statistics of Nice Maritime 145

Mr. R. **Valpy** on the Progress and Direction of British Exports, and the Influence thereon of Free Trade and Gold 145

Mr. **James Yates** on a Method of substituting Francs and Centimes for the present English Metallic Currency 146

MECHANICS.

Mr. **Frederick Bakewell** on Telegraphic Communication between England and America 147

Mr. **John Chanter** on the Œconomical Working of Steam Boilers 147

Mr. **William Clay** on the large Fly-wheel lately erected at the Mersey Iron-Works, Liverpool 147

Mr. J. **Cunningham** on Ventilation of Ships 148

Mr. W. **Day** on the Œconomical Working of Steam Boilers and Furnaces, by the saving of Fuel, with a more speedy command of Steam 149

Mr. H. **Dircks** on the Prevention of Boiler Explosions 149

Mr. J. **Eldridge** on a New Washing Machine 149

Mr. W. **Fairbairn** on the Consumption of Fuel and the Prevention of Smoke 149

——————— on the Solidification of Bodies under great Pressure 149

Mr. J. **Grantham** on Cunningham's Plan for Reefing Topsails 150

——————— on Fisher's Venetian Screw Propeller 151

Mr. **William Hawkes** on the Strength of Iron after repeated Meltings 151

Mr. **Andrew Henderson** on Ocean Steamers and Clipper Ships 152

Mr. J. B. **Lindsay** on some Experiments upon a Telegraph for communicating across Rivers and Seas, without the employment of a submerged Cable 157

Page
Mr. J. NASMYTH on a Method of Boring Holes in Rock for Tunneling Purposes 157
Mr. PROSSER on Unchanged Steam 159
Mr. W. J. MACQUORN RANKINE on the Means of realizing the advantages of the Air-Engine 159
Mr. JOHN SCOTT RUSSELL on the Progress of Naval Architecture and Steam Navigation, including a Notice of the large Ship of the Eastern Steam Navigation Company 160
Mr. SAXBY on Mechanical Appliances on board Merchant Ships........ 161
Rev. Dr. SCORESBY'S Inquiry as to the Principles and Measures on which Safety in the Navigation of Iron Ships may be reasonably looked for 161
Mr. JOHN SEWELL on Steam-boiler Explosions 162
Mr. ANDREW SMITH on the Origin of Wire Rope; its Qualities and Œconomy 162
Professor STEVELLY on the Limit of Weight which may safely be laid on a Pile driven into the Ground 163
Mr. J. STATHER on an Improved Printing Machine 163
Mr. J. THORNTON'S Report of Experiments on the Friction of Discs in Water and on the Experiments to be made on Centrifugal Pumps 163
Mr. J. B. LAWES and Dr. J. H. GILBERT on the Amounts of, and Methods of Estimating, Ammonia and Nitric Acid in Rain-water........ 164
Mr. W. RUSSELL'S Letter to John Cleghorn, Esq. on the Herring Fishery averages of Wick District 176

INDEX I.—To Reports on the State of Science 177
INDEX II.—To Miscellaneous Communications to the Sections 179

ADVERTISEMENT.

The Editors of the preceding Notices consider themselves responsible only for the fidelity with which the views of the Authors are abstracted.

OBJECTS AND RULES

OF

THE ASSOCIATION.

OBJECTS.

The Association contemplates no interference with the ground occupied by other Institutions. Its objects are,—To give a stronger impulse and a more systematic direction to scientific inquiry,—to promote the intercourse of those who cultivate Science in different parts of the British Empire, with one another, and with foreign philosophers,—to obtain a more general attention to the objects of Science, and a removal of any disadvantages of a public kind which impede its progress.

RULES.

ADMISSION OF MEMBERS AND ASSOCIATES.

All Persons who have attended the first Meeting shall be entitled to become Members of the Association, upon subscribing an obligation to conform to its Rules.

The Fellows and Members of Chartered Literary and Philosophical Societies publishing Transactions, in the British Empire, shall be entitled, in like manner, to become Members of the Association.

The Officers and Members of the Councils, or Managing Committees, of Philosophical Institutions, shall be entitled, in like manner, to become Members of the Association.

All Members of a Philosophical Institution recommended by its Council or Managing Committee, shall be entitled, in like manner, to become Members of the Association.

Persons not belonging to such Institutions shall be elected by the General Committee or Council, to become Life Members of the Association, Annual Subscribers, or Associates for the year, subject to the approval of a General Meeting.

COMPOSITIONS, SUBSCRIPTIONS, AND PRIVILEGES.

Life Members shall pay, on admission, the sum of Ten Pounds. They shall receive *gratuitously* the Reports of the Association which may be published after the date of such payment. They are eligible to all the offices of the Association.

Annual Subscribers shall pay, on admission, the sum of Two Pounds, and in each following year the sum of One Pound. They shall receive *gratuitously* the Reports of the Association for the year of their admission and for the years in which they continue to pay *without intermission* their Annual Subscription. By omitting to pay this Subscription in any particular year, Members of this class (Annual Subscribers) *lose for that and all future years* the privilege of receiving the volumes of the Association *gratis*: but they may resume their Membership and other privileges at any subsequent Meeting of the Association, paying on each such occasion the sum of One Pound. They are eligible to all the Offices of the Association.

Associates for the year shall pay on admission the sum of One Pound. They shall not receive *gratuitously* the Reports of the Association, nor be eligible to serve on Committees, or to hold any office.

The Association consists of the following classes :—

1. Life Members admitted from 1831 to 1845 inclusive, who have paid on admission Five Pounds as a composition.

2. Life Members who in 1846, or in subsequent years, have paid on admission Ten Pounds as a composition.

3. Annual Members admitted from 1831 to 1839 inclusive, subject to the payment of One Pound annually. [May resume their Membership after intermission of Annual Payment.]

4. Annual Members admitted in any year since 1839, subject to the payment of Two Pounds for the first year, and One Pound in each following year. [May resume their Membership after intermission of Annual Payment.]

5. Associates for the year, subject to the payment of One Pound.

6. Corresponding Members nominated by the Council.

And the Members and Associates will be entitled to receive the annual volume of Reports, *gratis*, or to *purchase* it at reduced (or Members') price, according to the following specification, viz. :—

1. *Gratis.*—Old Life Members who have paid Five Pounds as a composition for Annual Payments, and previous to 1845 a further sum of Two Pounds as a Book Subscription, or, since 1845, a further sum of Five Pounds.

   New Life Members who have paid Ten Pounds as a composition.

   Annual Members who have not intermitted their Annual Subscription.

2. *At reduced or Members' Prices*, viz. two-thirds of the Publication Price.—Old Life Members who have paid Five Pounds as a composition for Annual Payments, but no further sum as a Book Subscription.

   Annual Members, who have intermitted their Annual Subscription.

   Associates for the year. [Privilege confined to the volume for that year only.]

3. Members may purchase (for the purpose of completing their sets) any of the first seventeen volumes of Transactions of the Association, *and of which more than* 100 *copies remain*, at one-third of the Publication Price. Application to be made (by letter) to Messrs. Taylor & Francis, Red Lion Court, Fleet St., London.

Subscriptions shall be received by the Treasurer or Secretaries.

MEETINGS.

The Association shall meet annually, for one week, or longer. The place of each Meeting shall be appointed by the General Committee at the previous Meeting; and the Arrangements for it shall be entrusted to the Officers of the Association.

GENERAL COMMITTEE.

The General Committee shall sit during the week of the Meeting, or longer, to transact the business of the Association. It shall consist of the following persons :—

1. Presidents and Officers for the present and preceding years, with authors of Reports in the Transactions of the Association.

2. Members who have communicated any Paper to a Philosophical Society, which has been printed in its Transactions, and which relates to such subjects as are taken into consideration at the Sectional Meetings of the Association.

3. Office-bearers for the time being, or Delegates, altogether, not exceeding three in number, from any Philosophical Society publishing Transactions.

4. Office-bearers for the time being, or Delegates, not exceeding three, from Philosophical Institutions established in the place of Meeting, or in any place where the Association has formerly met.

5. Foreigners and other individuals whose assistance is desired, and who are specially nominated in writing for the meeting of the year by the President and General Secretaries.

6. The Presidents, Vice-Presidents, and Secretaries of the Sections are *ex officio* members of the General Committee for the time being.

SECTIONAL COMMITTEES.

The General Committee shall appoint, at each Meeting, Committees, consisting severally of the Members most conversant with the several branches of Science, to advise together for the advancement thereof.

The Committees shall report what subjects of investigation they would particularly recommend to be prosecuted during the ensuing year, and brought under consideration at the next Meeting.

The Committees shall recommend Reports on the state and progress of particular Sciences, to be drawn up from time to time by competent persons, for the information of the Annual Meetings.

COMMITTEE OF RECOMMENDATIONS.

The General Committee shall appoint at each Meeting a Committee, which shall receive and consider the Recommendations of the Sectional Committees, and report to the General Committee the measures which they would advise to be adopted for the advancement of Science.

All Recommendations of Grants of Money, Requests for Special Researches, and Reports on Scientific Subjects, shall be submitted to the Committee of Recommendations, and not taken into consideration by the General Committee, unless previously recommended by the Committee of Recommendations.

LOCAL COMMITTEES.

Local Committees shall be formed by the Officers of the Association to assist in making arrangements for the Meetings.

Local Committees shall have the power of adding to their numbers those Members of the Association whose assistance they may desire.

OFFICERS.

A President, two or more Vice-Presidents, one or more Secretaries, and a Treasurer, shall be annually appointed by the General Committee.

COUNCIL.

In the intervals of the Meetings, the affairs of the Association shall be managed by a Council appointed by the General Committee. The Council may also assemble for the despatch of business during the week of the Meeting.

PAPERS AND COMMUNICATIONS.

The Author of any paper or communication shall be at liberty to reserve his right of property therein.

ACCOUNTS.

The Accounts of the Association shall be audited annually, by Auditors appointed by the Meeting.

Table showing the Places and Times of Meeting of the British Association, with Presidents, Vice-Presidents, and Local Secretaries, from its Commencement.

PRESIDENTS.	VICE-PRESIDENTS.	LOCAL SECRETARIES.
The EARL FITZWILLIAM, D.C.L., F.R.S., F.G.S., &c. York, September 27, 1831.	Rev. W. Vernon Harcourt, M.A., F.R.S., F.G.S.	William Gray, jun., F.G.S. Professor Phillips, M.A., F.R.S., F.G.S.
The REV. W. BUCKLAND, D.D., F.R.S., F.G.S., &c. Oxford, June 19, 1832.	Sir David Brewster, F.R.S.L. & E., &c. Rev. W. Whewell, F.R.S., Pres. Geol. Soc.	Professor Daubeny, M.D., F.R.S., &c. Rev. Professor Powell, M.A., F.R.S., &c.
The REV. ADAM SEDGWICK, M.A., V.P.R.S., V.P.G.S. Cambridge, June 25, 1833.	G. B. Airy, F.R.S., Astronomer Royal, &c. John Dalton, D.C.L., F.R.S.	Rev. Professor Henslow, M.A., F.L.S., F.G.S. Rev. W. Whewell, F.R.S.
Sir T. MAKDOUGALL BRISBANE, K.C.B., D.C.L., F.R.S. L. & E. Edinburgh, September 8, 1834.	Sir David Brewster, F.R.S., &c. Rev. T. R. Robinson, D.D.	Professor Forbes, F.R.S. L. & E., &c. Sir John Robison, Sec. R.S.E.
The REV. PROVOST LLOYD, LL.D. Dublin, August 10, 1835.	Viscount Oxmantown, F.R.S., F.R.A.S. Rev. W. Whewell, F.R.S., &c.	Sir W. R. Hamilton, Astron. Royal of Ireland, &c. Rev. Professor Lloyd, F.R.S.
The MARQUIS OF LANSDOWNE, D.C.L., F.R.S., &c. Bristol, August 22, 1836.	The Marquis of Northampton, F.R.S. Rev. W. D. Conybeare, F.R.S., F.G.S. J. C. Prichard, M.D., F.R.S.	Professor Daubeny, M.D., F.R.S., &c. V. F. Hovenden, Esq.
The EARL OF BURLINGTON, F.R.S., F.G.S., Chancellor of the University of London. Liverpool, September 11, 1837.	The Bishop of Norwich, P.L.S., F.G.S. John Dalton, D.C.L., F.R.S. Sir Philip de Grey Egerton, Bart., F.R.S., F.G.S. Rev. W. Whewell, F.R.S.	Professor Traill, M.D. Wm. Wallace Currie, Esq. Joseph N. Walker, Pres. Royal Institution, Liverpool.
The DUKE OF NORTHUMBERLAND, F.R.S., F.G.S., &c. Newcastle-on-Tyne, August 20, 1838.	The Bishop of Durham, F.R.S., F.S.A. The Rev. W. Vernon Harcourt, F.R.S., &c. Prideaux John Selby, Esq., F.R.S.E.	John Adamson, F.L.S., &c. Wm. Hutton, F.G.S. Professor Johnston, M.A., F.R.S.
The REV. W. VERNON HARCOURT, M.A., F.R.S., &c. Birmingham, August 26, 1839.	Marquis of Northampton. Earl of Dartmouth. The Rev. T. R. Robinson, D.D. John Corrie, Esq., F.R.S. Very Rev. Principal Macfarlane	George Barker, Esq., F.R.S. Peyton Blakiston, M.D. Joseph Hodgson, Esq., F.R.S. Follett Osler, Esq.
The MARQUIS OF BREADALBANE, F.R.S. Glasgow, September 17, 1840.	Major-General Lord Greenock, F.R.S.E. Sir David Brewster, F.R.S. Sir T. M. Brisbane, Bart., F.R.S. The Earl of Mount Edgecumbe.	Andrew Liddell, Esq. Rev. J. P. Nicol, LL.D. John Strang, Esq.

The REV. PROFESSOR WHEWELL, F.R.S., &c. PLYMOUTH, July 29, 1841.	The Earl of Morley. Lord Eliot, M.P. Sir C. Lemon, Bart. Sir T. D. Acland, Bart.	W. Snow Harris, Esq., F.R.S. Col. Hamilton Smith, F.L.S. Robert Were Fox, Esq. Richard Taylor, jun., Esq.
The LORD FRANCIS EGERTON, F.G.S. MANCHESTER, June 23, 1842.	John Dalton, D.C.L., F.R.S. Hon. and Rev. W. Herbert, F.L.S., &c. Rev. A. Sedgwick, M.A., F.R.S. W. C. Henry, M.D., F.R.S. Sir Benjamin Heywood, Bart.	Peter Clare, Esq., F.R.A.S. W. Fleming, M.D. James Heywood, Esq., F.R.S.
The EARL OF ROSSE, F.R.S. CORK, August 17, 1843.	Earl of Listowel. Viscount Adare. Sir W. R. Hamilton, Pres.R.I.A. Rev. T. R. Robinson, D.D.	Professor John Stevelly, M.A. Rev. Jos. Carson, F.T.C. Dublin. William Kelcher, Esq. Wm. Clear, Esq.
The REV. G. PEACOCK, D.D. (Dean of Ely), F.R.S. YORK, September 26, 1844.	Earl Fitzwilliam, F.R.S. Viscount Morpeth, F.G.S. The Hon. John Stuart Wortley, M.P. Sir David Brewster, K.H., F.R.S. Michael Faraday, Esq., D.C.L., F.R.S. Rev. W. V. Harcourt, F.R.S.	William Hatfeild, Esq., F.G.S. Thomas Meynell, Esq., F.L.S. Rev. W. Scoresby, LL.D., F.R.S. William West, Esq.
Sir JOHN F. W. HERSCHEL, Bart., F.R.S., &c. CAMBRIDGE, June 19, 1845.	The Earl of Hardwicke. The Bishop of Norwich Rev. J. Graham, D.D. Rev. G. Ainslie, D.D. G. B. Airy, Esq., M.A., D.C.L., F.R.S. The Rev. Professor Sedgwick, M.A., F.R.S.	William Hopkins, Esq., M.A., F.R.S. Professor Ansted, M.A., F.R.S.
SIR RODERICK IMPEY MURCHISON, G.C.St.S., F.R.S. SOUTHAMPTON, September 10, 1846.	The Marquis of Winchester. The Earl of Yarborough, D.C.L. Lord Ashburton, D.C.L. Viscount Palmerston, M.P. Right Hon. Charles Shaw Lefevre, M.P. Sir George T. Staunton, Bart., M.P., D.C.L., F.R.S. The Lord Bishop of Oxford, F.R.S. Professor Owen, M.D., F.R.S. Professor Powell, F.R.S.	Henry Clark, M.D. T. H. C. Moody, Esq.
SIR ROBERT HARRY INGLIS, Bart., D.C.L., F.R.S., M.P. for the University of Oxford OXFORD, June 23, 1847.	The Earl of Rosse, F.R.S. The Lord Bishop of Oxford, F.R.S. The Vice-Chancellor of the University Thomas G. Bucknall Estcourt, Esq., D.C.L., M.P. for the University of Oxford. Very Rev. the Dean of Westminster, D.D., F.R.S. Professor Daubeny, M.D., F.R.S. The Rev. Prof. Powell, M.A., F.R.S.	Rev. Robert Walker, M.A., F.R.S. Rev. Wentworth Ackland, Esq., B.M.
The MARQUIS OF NORTHAMPTON, President of the Royal Society, &c. SWANSEA, August 9, 1848.	The Marquis of Bute, K.T. Viscount Adare, F.R.S. Sir H. T. De la Beche, F.R.S., Pres. G.S. The Very Rev. the Dean of Llandaff, F.R.S. Lewis W. Dillwyn, Esq., F.R.S. W. R. Grove, Esq., F.R.S. J. H. Vivian, Esq., M.P., F.R.S. The Lord Bishop of St. David's	Matthew Moggridge, Esq. D. Nicol, M.D.
The REV. T. R. ROBINSON, D.D., M.R.I.A., F.R.A.S. BIRMINGHAM, September 12, 1849.	The Earl of Harrowby. The Lord Wrottesley, F.R.S. Right Hon. Sir Robert Peel, Bart., M.P., D.C.L., F.R.S. Charles Darwin, Esq., M.A., F.R.S., Sec. G.S. Professor Faraday, D.C.L., F.R.S. Sir David Brewster, K.H., LL.D., F.R.S. Rev. Prof. Willis, M.A., F.R.S.	Captain Tindal, R.N. William Wills, Esq. Bell Fletcher, Esq., M.D. James Chance, Esq.

PRESIDENTS.	VICE-PRESIDENTS.	LOCAL SECRETARIES.
Sir DAVID BREWSTER, K.H., LL.D., F.R.S. L. & E., Principal of the United College of St. Salvator and St. Leonard, St. Andrews. EDINBURGH, July 31, 1850.	Right Hon. the Lord Provost of Edinburgh. The Earl of Cathcart, K.C.B., F.R.S.E. The Earl of Rosebery, K.T., D.C.L., F.R.S. Right Hon. David Boyle (Lord Justice-General), F.R.S.E. General Sir Thomas M. Brisbane, Bart., D.C.L., F.R.S., Pres. R.S.E. Very Rev. John Lee, D.D., V.P.R.S.E., Principal of the University of Edinburgh. Professor W. P. Alison, M.D., V.P.R.S.E. Professor J. D. Forbes, F.R.S., Sec. R.S.E.	Rev. Professor Kelland, M.A., F.R.S.L. & E. Professor Balfour, M.D., F.R.S.E., F.L.S. James Tod, Esq., F.R.S.E.
GEORGE BIDDELL AIRY, Esq., D.C.L., F.R.S., Astronomer Royal. IPSWICH, July 2, 1851.	The Lord Rendlesham, M.P. The Lord Bishop of Norwich. Rev. Professor Sedgwick, M.A., F.R.S. Rev. Professor Henslow, M.A., F.L.S. Sir John P. Boileau, Bart., F.R.S. Sir William F. F. Middleton, Bart. J. C. Cobbold, Esq., M.P. T. B. Western, Esq.	Charles May, Esq., F.R.A.S. Dillwyn Sims, Esq. George Arthur Biddell, Esq. George Ransome, Esq., F.L.S.
COLONEL EDWARD SABINE, Royal Artillery, Treas. & V.P. of the Royal Society BELFAST, September 1, 1852.	The Earl of Enniskillen, D.C.L., F.R.S. The Earl of Rosse, M.R.I.A., Pres. R.S. Sir Henry T. De la Beche, F.R.S. Rev. Edward Hincks, D.D., M.R.I.A. Rev. P. S. Henry, D.D., Pres. Queen's College, Belfast. Rev. T. R. Robinson, D.D., Pres. R.I.A., F.R.A.S. Professor G. G. Stokes, F.R.S. Professor Stevelly, LL.D.	W. J. C. Allen, Esq. William M'Gee, M.D. Professor W. P. Wilson.
WILLIAM HOPKINS, Esq., M.A., V.P.R.S., F.G.S., & Pres. Camb. Phil. Society HULL, September 7, 1853.	The Earl of Carlisle, F.R.S. Lord Londesborough, F.R.S. Professor Faraday, D.C.L., F.R.S. Rev. Prof. Sedgwick, M.A., F.R.S. Charles Frost, Esq., F.S.A., Pres. of the Hull Lit. and Philos. Society. William Spence, Esq., F.R.S. Lieut.-Col. Sykes, F.R.S. Professor Wheatstone, F.R.S.	Henry Cooper, M.D., V.P. Hull Lit. & Phil. Society. Bethel Jacobs, Esq., Pres. Hull Mechanics' Inst.
The EARL OF HARROWBY, F.R.S. LIVERPOOL, September 20, 1854.	The Lord Wrottesley, M.A., F.R.S., F.R.A.S Sir Philip de Malpas Grey Egerton, Bart., M.P., F.R.S., F.G.S. Professor Owen, M.D., LL.D., F.R.S., F.L.S., F.G.S. Rev. Professor Whewell, D.D., F.R.S., Hon. M.R.I.A., F.G.S., Master of Trinity College, Cambridge. William Lassell, Esq., F.R.S. L. & E., F.R.A S. Joseph Brooks Yates, Esq., F.S.A., F.R.G.S.	Joseph Dickinson, M.D., F.R.S. Thomas Inman, M.D.
The DUKE OF ARGYLL, F.R.S., F.G.S. GLASGOW, September 12, 1855.	The Very Rev. Principal M^cFarlane, D.D. Sir William Jardine, Bart., F.R.S.E. Sir Charles Lyell, M.A., LL.D., F.R.S. James Smith, Esq., F.R.S. L. & E. Walter Crum, Esq., F.R.S. Thomas Graham, Esq., M.A., F.R.S., Master of the Royal Mint Professor William Thomson, M.A., F.R.S.	John Strang, LL.D. Prof. Thomas Anderson, M.D. William Gourlie, Esq.

II. Table showing the Names of Members of the British Association who have served on the Council in former years.

Acland, Sir Thomas D., Bart., M.P., F.R.S.
Acland, Professor H. W., B.M., F.R.S.
Adamson, John, Esq., F.L.S.
Adams, J. Couch, M.A., F.R.S.
Adare, Edwin, Viscount, M.P., F.R.S.
Ainslie, Rev. Gilbert, D.D., Master of Pembroke Hall, Cambridge.
Airy, G.B., D.C.L., F.R.S., Astronomer Royal.
Alison, Professor W. P., M.D., F.R.S.E.
Ansted, Professor D. T., M.A., F.R.S.
Argyll, George Douglas, Duke of, F.R.S.
Arnott, Neil, M.D., F.R.S.
Ashburton, William Bingham, Lord, D.C.L.
Babbage, Charles, Esq., F.R.S.
Babington, C. C., Esq., F.R.S.
Baily, Francis, Esq., F.R.S.
Balfour, Professor John H., M.D.
Barker, George, Esq., F.R.S.
Bell, Professor Thomas, F.L.S., F.R.S.
Bengough, George, Esq.
Bentham, George, Esq., F.L.S.
Bigge, Charles, Esq.
Blakiston, Peyton, M.D., F.R.S.
Boileau, Sir John P., Bart., F.R.S.
Boyle, Right Hon. David, Lord Justice-General, F.R.S.E.
Brand, William, Esq.
Brewster, Sir David, K.H., D.C.L., LL.D., F.R.S., Principal of the United College of St. Salvator and St. Leonard, St. Andrews.
Breadalbane, John, Marquis of, K.T., F.R.S.
Brisbane, General Sir Thomas M., Bart., K.C.B., G.C.H., D.C.L., F.R.S.
Brown, Robert, D.C.L., F.R.S.
Brunel, Sir M. I., F.R.S.
Buckland, Very Rev. William, D.D., Dean of Westminster, F.R.S.
Burlington, William, Earl of, M.A., F.R.S., Chancellor of the University of London.
Bute, John, Marquis of, K.T.
Carlisle, George Will. Fred., Earl of, F.R.S.
Carson, Rev. Joseph.
Cathcart, Lt.-Gen., Earl of, K.C.B., F.R.S.E.
Chalmers, Rev. T., D.D., late Professor of Divinity, Edinburgh.
Chance, James, Esq.
Chester, John Graham, D.D., Lord Bishop of.
Christie, Professor S. H., M.A., Sec. R.S.
Clare, Peter, Esq., F.R.A.S.
Clark, Rev. Prof., M.D., F.R.S. (Cambridge).
Clark, Henry, M.D.
Clark, G. T., Esq.
Clear, William, Esq.
Clerke, Major Shadwell, K.H., R.E., F.R.S.
Clift, William, Esq., F.R.S.
Cobbold, John Chevalier, Esq., M.P.
Colquhoun, J. C., Esq., M.P.
Conybeare, Very Rev. W. D., Dean of Llandaff, M.A., F.R.S.
Corrie, John, Esq., F.R.S.
Currie, William Wallace, Esq.
Dalton, John, D.C.L., F.R.S.
Daniell, Professor J. F., F.R.S.
Dartmouth, William, Earl of, D.C.L., F.R.S.
Darwin, Charles, Esq., F.R.S.
Daubeny, Prof. Charles G. B., M.D., F.R.S.
De la Beche, Sir Henry T., C.B., F.R.S., Director-General of the Geological Survey of the United Kingdom.
Dillwyn, Lewis W., Esq., F.R.S.
Drinkwater, J. E., Esq.
Durham, Edward Maltby, D.D., Lord Bishop of, F.R.S.
Egerton, Sir Philip de M. Grey, Bart., M.P., F.R.S.
Eliot, Lord, M.P.
Ellesmere, Francis, Earl of, F.G.S.
Enniskillen, William, Earl of, D.C.L., F.R.S.
Estcourt, T. G. B., D.C.L.
Faraday, Professor, D.C.L., F.R.S.
Fitzwilliam, Charles William, Earl, D.C.L., F.R.S.
Fleming, W., M.D.
Fletcher, Bell, M.D.
Forbes, Charles, Esq.
Forbes, Professor Edward, F.R.S.
Forbes, Professor J. D., F.R.S., Sec. R.S.E.
Fox, Robert Were, Esq., F.R.S.
Frost, Charles, F.S.A.
Gassiot, John P., Esq., F.R.S.
Gilbert, Davies, D.C.L., F.R.S.
Graham, Professor Thomas, M.A., F.R.S.
Gray, John E., Esq., F.R.S.
Gray, Jonathan, Esq.
Gray, William, jun., Esq., F.G.S.
Green, Professor Joseph Henry, F.R.S.
Greenough, G. B., Esq., F.R.S.
Grove, W. R., Esq., F.R.S.
Hallam, Henry, Esq., M.A., F.R.S.
Hamilton, W. J., Esq., Sec.G.S.
Hamilton, Sir William R., Astronomer Royal of Ireland, M.R.I.A.
Harcourt, Rev. William Vernon, M.A., F.R.S.
Hardwicke, Charles Philip, Earl of, F.R.S.
Harford, J. S., D.C.L., F.R.S.
Harris, Sir W. Snow, F.R.S.
Harrowby, The Earl of, F.R.S.
Hatfeild, William, Esq., F.G.S.
Henslow, Rev. Professor, M.A., F.L.S.
Henry, W. C., M.D., F.R.S.
Henry, Rev. P. S., D.D., President of Queen's College, Belfast.
Herbert, Hon. and Very Rev. William, late Dean of Manchester, LL.D., F.L.S.
Herschel, Sir John F. W., Bart., D.C.L., F.R.S.
Heywood, Sir Benjamin, Bart., F.R.S.
Heywood, James, Esq., M.P., F.R.S.
Hill, Rev. Edward, M.A., F.G.S.
Hincks, Rev. Edward, D.D., M.R.I.A.
Hodgkin, Thomas, M.D.
Hodgkinson, Professor Eaton, F.R.S.
Hodgson, Joseph, Esq., F.R.S.
Hooker, Sir William J., LL.D., F.R.S.
Hope, Rev. F. W., M.A., F.R.S.
Hopkins, William, Esq., M.A., F.R.S.
Horner, Leonard, Esq., F.R.S., F.G.S.
Hovenden, V. F., Esq., M.A.
Hutton, Robert, Esq., F.G.S.
Hutton, William, Esq., F.G.S.
Ibbetson, Capt. L. L. Boscawen, K.R.E., F.G.S.
Inglis, Sir Robert H., Bart., D.C.L., M.P., F.R.S.
Jameson, Professor R., F.R.S.
Jeffreys, John Gwyn, Esq., F.R.S.
Jenyns, Rev. Leonard, F.L.S.
Jerrard, H. B., Esq.
Johnston, Right Hon. William, Lord Provost of Edinburgh.
Johnston, Professor J. F. W., M.A., F.R.S.

Keleher, William, Esq.
Kelland, Rev. Professor P., M.A.
Lankester, Edwin, M.D., F.R.S.
Lansdowne, Henry, Marquis of, D.C.L., F.R.S.
Lardner, Rev. Dr.
Lassell, William, Esq., F.R.S. L. & E.
Latham, R. G., M.D., F.R.S.
Lee, Very Rev. John, D.D., F.R.S.E., Principal of the University of Edinburgh.
Lee, Robert, M.D., F.R.S.
Lefevre, Right Hon. Charles Shaw, Speaker of the House of Commons.
Lemon, Sir Charles, Bart., M.P., F.R.S.
Liddell, Andrew, Esq.
Lindley, Professor John, Ph.D., F.R.S.
Listowel, The Earl of.
Lloyd, Rev. Bartholomew, D.D., late Provost of Trinity College, Dublin.
Lloyd, Rev. Professor, D.D., Provost of Trinity College, Dublin, F.R.S.
Londesborough, Lord, F.R.S.
Lubbock, Sir John W., Bart., M.A., F.R.S.
Luby, Rev. Thomas.
Lyell, Sir Charles, M.A., F.R.S.
MacCullagh, Professor, D.C.L., M.R.I.A.
Macfarlane, The Very Rev. Principal.
MacLeay, William Sharp, Esq., F.L.S.
MacNeill, Professor Sir John, F.R.S.
Malcolm, Vice Admiral Sir Charles, K.C.B.
Manchester, J. P. Lee, D.D., Lord Bishop of.
Meynell, Thomas, Jun., Esq., F.L.S.
Middleton, Sir William F. F., Bart.
Miller, Professor W. A., M.D., F.R.S.
Miller, Professor W. H., M.A., F.R.S.
Moillet, J. D., Esq.
Moggridge, Matthew, Esq.
Moody, J. Sadleir, Esq.
Moody, T. H. C., Esq.
Moody, T. F., Esq.
Morley, The Earl of.
Moseley, Rev. Henry, M.A., F.R.S.
Mount-Edgecumbe, Ernest Augustus, Earl of.
Murchison, Sir Roderick I., G.C.St.S., F.R.S.
Neill, Patrick, M.D., F.R.S.E.
Nicol, D., M.D.
Nicol, Rev. J. P., LL.D.
Northumberland, Hugh, Duke of, K.G., M.A., F.R.S.
Northampton, Spencer Joshua Alwyne, Marquis of, V.P.R.S.
Norwich, Edward Stanley, D.D., F.R.S., late Lord Bishop of.
Norwich, Samuel Hinds, D.D., Lord Bishop of.
Ormerod, G. W., Esq., F.G.S.
Orpen, Thomas Herbert, M.D.
Orpen, J. H., LL.D.
Owen, Professor Richard, M.D., F.R.S.
Oxford, Samuel Wilberforce, D.D., Lord Bishop of, F.R.S., F.G.S.
Osler, Follett, Esq.
Palmerston, Viscount, G.C.B., M.P.
Peacock, Very Rev. George, D.D., Dean of Ely, F.R.S.
Peel, Rt. Hon. Sir Robert, Bart., M.P., D.C.L., F.R.S.
Pendarves, E., Esq., F.R.S.
Phillips, Professor John, M.A., F.R.S.
Porter, G. R., Esq.
Powell, Rev. Professor, M.A., F.R.S.
Prichard, J. C., M.D., F.R.S.
Ramsay, Professor W., M.A.
Reid, Lieut.-Col. Sir William, F.R.S.
Rendlesham, Rt. Hon. Lord, M.P.
Rennie, George, Esq., V.P.R.S.
Rennie, Sir John, F.R.S.
Richardson, Sir John, M.D., F.R.S.
Ritchie, Rev. Professor, LL.D., F.R.S.
Robinson, Rev. J., D.D.
Robinson, Rev. T. R., D.D., Pres.R.I.A., F.R.A.S.
Robison, Sir John, late Sec.R.S.Edin.
Roche, James, Esq.
Roget, Peter Mark, M.D., F.R.S.
Ronalds, Francis, F.R.S.
Rosebery, The Earl of, K.T., D.C.L., F.R.S.
Ross, Capt. Sir James C., R.N., F.R.S.
Rosse, William, Earl of, M.A., M.R.I.A., President of the Royal Society.
Royle, Professor John F., M.D., F.R.S.
Russell, James, Esq.
Russell, J. Scott, Esq., F.R.S.
Sabine, Col. Edward, R.A., Treas. & V.P. R.S.
Saunders, William, Esq., F.G.S.
Sandon, Lord (the present Earl of Harrowby).
Scoresby, Rev. W., D.D., F.R.S.
Sedgwick, Rev. Professor Adam, M.A., F.R.S.
Selby, Prideaux John, Esq., F.R.S.E.
Smith, Lieut.-Colonel C. Hamilton, F.R.S.
Spence, William, Esq., F.R.S.
Staunton, Sir G. T., Bt., M.P., D.C.L., F.R.S.
St. David's, C. Thirlwall, D.D., Lord Bishop of.
Stevelly, Professor John, LL.D.
Stokes, Professor G. G., F.R.S.
Strang, John, Esq.
Strickland, Hugh Edwin, Esq., F.R.S.
Sykes, Lieut.-Colonel W. H., F.R.S.
Symonds, B. P., D.D., late Vice-Chancellor of the University of Oxford.
Talbot, W. H. Fox, Esq., M.A., F.R.S.
Tayler, Rev. John James, B.A.
Taylor, John, Esq., F.R.S.
Taylor, Richard, Jun., Esq., F.G.S.
Thompson, William, Esq., F.L.S.
Tindal, Captain, R.N.
Tod, James, Esq., F.R.S.E.
Traill, J. S., M.D.
Turner, Edward, M.D., F.R.S.
Turner, Samuel, Esq., F.R.S., F.G.S.
Turner, Rev. W.
Vigors, N. A., D.C.L., F.L.S.
Vivian, J. H., M.P., F.R.S.
Walker, James, Esq., F.R.S.
Walker, Joseph N., Esq., F.G.S.
Walker, Rev. Robert, M.A., F.R.S.
Warburton, Henry, Esq., M.A., M.P., F.R.S.
Washington, Captain, R.N.
West, William, Esq., F.R.S.
Western, Thomas Burch, Esq.
Wharncliffe, John Stuart, Lord, F.R.S.
Wheatstone, Professor Charles, F.R.S.
Whewell, Rev. William, D.D., F.R.S., Master of Trinity College, Cambridge.
Williams, Professor Charles J.B., M.D., F.R.S.
Willis, Rev. Professor Robert, M.A., F.R.S.
Wills, William, Esq.
Winchester, John, Marquis of.
Woollcombe, Henry, Esq., F.S.A.
Wrottesley, John, Lord, M.A., Pres. R.S.
Yarrell, William, Esq., F.L.S.
Yarborough, The Earl of, D.C.L.
Yates, James, Esq., M.A., F.R.S.
Yates, Joseph Brooks, Esq., F.S.A., F.R.G.S.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

THE GENERAL TREASURER'S ACCOUNT from 5th of Sept. 1853 (at Hull) to the 18th of Sept. 1854 (at Liverpool).

RECEIPTS.

	£	s.	d.
To Balance brought on from last account	227	19	11
Life Compositions at Hull and since	180	0	0
Annual Subscriptions at Hull and since	226	0	0
Associates' Tickets at Hull	367	0	0
Ladies' Tickets at Hull	236	0	0
Twelve months' Dividends on £3500, 3 per cent. Consols	100	8	2
From the Sale of Publications, viz.—Reports, Catalogues of Stars, &c.	179	13	6
	£1517	1	7

A. FOLLETT OSLER,
J. P. GASSIOT, } *Auditors.*

PAYMENTS.

	£	s.	d.	£	s.	d.
For Expenses of Meeting at Hull, Sundry Printing, Advertising, Binding, and Petty Disbursements made by the General Treasurer and the Local Treasurers				134	2	9
Printing Report of the 22nd Meeting				438	16	3
Engraving for the Report of the 23rd Meeting				45	18	6
Dove's Distribution of Heat				70	9	0
Salaries, 12 Months				350	0	0
Maintaining the Establishment of Kew Observatory, viz.—Balance of former Grant	130	15	4			
Grant voted at last Meeting	200	0	0			
				330	15	4
On Account of Grants, viz.—for						
Investigations on Flax				11	0	0
Inquiries into the Effects of Temperature on Wrought Iron				10	0	0
Registration of Periodical Phænomena				10	0	0
Report on British Annelida				10	0	0
Experiments on the Vitality of Seeds				5	2	3
Inquiry on Conduction of Heat				4	2	0
Balance at the Bankers	90	12	6			
Balance in the hands of the General Treasurer and Local Treasurers	6	3	0			
				96	15	6
				£1517	1	7

OFFICERS AND COUNCIL, 1853–54.

TRUSTEES (PERMANENT).

Sir Roderick I. Murchison, G.C.St.S., F.R.S.
John Taylor, Esq., F.R.S.
The Very Rev. George Peacock, D.D., Dean of Ely, F.R.S.

PRESIDENT.

The Earl of Harrowby, F.R.S.

VICE-PRESIDENTS.

The Lord Wrottesley, M.A., Pres. R.S., F.R.A.S.
Sir Philip De Malpas Grey Egerton, Bart., M.P., F.R.S., F.G.S.
Richard Owen, M.D., LL.D., F.R.S., F.L.S., F.G.S., Hunterian Professor of Anatomy and Physiology in the Royal College of Surgeons of England.
Rev. William Whewell, D.D., Pres. R.S., Hon. M.R.I.A., F.G.S., F.R.A.S., Master of Trinity College, and Professor of Moral Philosophy in the University of Cambridge.
William Lassell, Esq., F.R.S. L. & E., F.R.A.S.
Joseph Brooks Yates, Esq., F.S.A., F.R.G.S.

PRESIDENT ELECT.

The Duke of Argyll, F.R.S.

VICE-PRESIDENTS ELECT.

The Very Rev. Principal McFarlane, D.D.
Sir William Jardine, Bt., F.R.S.E., F.L.S.
Sir Charles Lyell, M.A., LL.D., F.R.S., Hon. Mem. R.S.Ed., F.L.S., F.G.S.
James Smith, Esq., F.R.S.L. & E., F.G.S., F.R.G.S., M.W.S.
Walter Crum, Esq., F.R.S.
Thomas Graham, M.A., F.R.S., Hon. Mem. R.S.Ed., F.G.S., Master of the Royal Mint.
William Thomson, M.A., F.R.S. L. & E., Professor of Natural Philosophy in the University of Glasgow.

LOCAL SECRETARIES FOR THE MEETING AT GLASGOW.

John Strang, LL.D., City Chamberlain of Glasgow.
Thomas Anderson, M.A., Regius Professor of Chemistry in the University of Glasgow.
William Gourlie, Esq.

LOCAL TREASURER FOR THE MEETING AT GLASGOW.

William Ramsay, M.A., Professor of Humanity in the University of Glasgow.

ORDINARY MEMBERS OF THE COUNCIL.

Arnott, Neil, M.D., F.R.S.
Babington, C. C., F.R.S.
Bell, Prof., Pres.L.S., F.R.S.
Brooke, Charles, Esq., B.A., F.R.S.
Daubeny, Prof., M.D., F.R.S.
Gassiot, John P., F.R.S.
Grove, William R., F.R.S.
Heywood, James, Esq., M.P.
Horner, L., Esq., F.R.S.
Hutton, Robert, F.G.S.
Lankester, E., M.D., F.R.S.
Latham, R. G., M.D., F.R.S.
Miller, Prof. W. A., M.D., F.R.S.
Milnes, R. M., Esq., M.P.
Powell, Rev. Prof., F.R.S.
Royle, J. F., M.D., F.R.S.
Stokes, Professor, F.R.S.
Sykes, Lt.-Col. W. H., F.R.S.
Tite, W., M.P., F.S.A., F.R.S.
Tooke, T., Esq., F.R.S.
Wheatstone, Prof., F.R.S.

EX-OFFICIO MEMBERS OF THE COUNCIL.

The President and President Elect, the Vice-Presidents and Vice-Presidents Elect, the General and Assistant-General Secretaries, the General Treasurer, the Trustees, and the Presidents of former years, viz. The Earl Fitzwilliam. Rev. Dr. Buckland. Rev. Professor Sedgwick. Sir Thomas M. Brisbane. The Marquis of Lansdowne. The Earl of Burlington. Rev. W. V. Harcourt. The Marquis of Breadalbane. Rev. Dr. Whewell. The Earl of Ellesmere. The Earl of Rosse. The Dean of Ely. Sir John F. W. Herschel, Bart. Sir Roderick I. Murchison. The Rev. Dr. Robinson. Sir David Brewster. G. B. Airy, Esq., the Astronomer Royal. Colonel Sabine. William Hopkins, Esq., F.R.S.

GENERAL SECRETARY.

Colonel Edward Sabine, R.A., Treas. & V.P.R.S., F.R.A.S., Woolwich.

ASSISTANT GENERAL SECRETARY.

John Phillips, Esq., M.A., F.R.S., F.G.S., Deputy Reader in Geology in the University of Oxford; Magdalen Bridge, Oxford.

GENERAL TREASURER.

John Taylor, Esq., F.R.S., 6 Queen Street Place, Upper Thames Street, London.

LOCAL TREASURERS.

William Gray, Esq., F.G.S., *York.*
C. C. Babington, Esq., M.A., F.R.S., *Cambridge.*
William Brand, Esq., *Edinburgh.*
John H. Orpen, LL.D., *Dublin.*
William Sanders, Esq., F.G.S., *Bristol.*
Robert M'Andrew, Esq., F.R.S., *Liverpool.*
W. R. Wills, Esq., *Birmingham.*
Professor Ramsay, M.A., *Glasgow.*
Robert P. Greg, Esq., *Manchester.*
J. Sadleir Moody, Esq., *Southampton.*
John Gwyn Jeffreys, Esq., F.R.S., *Swansea.*
J. B. Alexander, Esq., *Ipswich.*
Robert Patterson, Esq., *Belfast.*
Edmund Smith, Esq., *Hull.*

AUDITORS.

J. P. Gassiot, Esq.
C. C. Babington, Esq.
A. Follett Osler, Esq.

OFFICERS OF SECTIONAL COMMITTEES PRESENT AT THE LIVERPOOL MEETING.

SECTION A.—MATHEMATICS AND PHYSICS.

President.—G. G. Stokes, M.A., Sec.R.S., Luc. Prof. Camb.

Vice-Presidents.—Very Rev. The Dean of Ely, F.R.S.; Rev. Professor Walker, F.R.S.; Rev. Dr. Whewell, F.R.S.; Rev. Professor Powell, F.R.S.

Secretaries.—Prof. Stevelly, LL.D.; Prof. John Tyndall, Ph.D., F.R.S.; Hale G. Puckle, M.A.; J. Hartnup, Esq., F.R.A.S.; John Welsh, Esq.

SECTION B.—CHEMISTRY AND MINERALOGY, INCLUDING THEIR APPLICATIONS TO AGRICULTURE AND THE ARTS.

President.—W. A. Miller, M.D., F.R.S., Prof. Chem. King's Coll. Lond.

Vice-Presidents.—Professor M. Faraday, D.C.L., F.R.S.; Professor Thomas Graham, F.R.S.; Professor T. Traill, M.D., F.R.S.E.; R. Warington, Esq., F.C.S.

Secretaries.—J. Baker Edwards, Ph.D., F.C.S.; J. H. Gladstone, Ph.D., F.R.S.; David S. Price, Ph.D., F.C.S.

SECTION C.—GEOLOGY.

President.—Edward Forbes, F.R.S., Prof. Nat. Hist. Edin.

Vice-Presidents.—Rev. Prof. Sedgwick, F.R.S.; Lt.-Col. Portlock, F.R.S.; James Smith, Esq., F.R.S.; G. B. Greenough, Esq., F.R.S.; Sir Charles Lyell, F.R.S.

Secretaries.—John Cunningham, Esq., F.G.S.; G. W. Ormerod. M.A., F.G.S.; J. W. Woodall, B.A.; Professor Harkness, F.G.S.

SECTION D.—ZOOLOGY AND BOTANY, INCLUDING PHYSIOLOGY.

President.—Professor Balfour, M.D., F.R.S.E.

Vice-Presidents.—William Carpenter, M.D., F.R.S.; C. C. Babington, Esq., M.A., F.R.S.; T. H. Huxley, F.R.S.; Sir W. Jardine, Bart., F.R.S.E.

Secretaries.—Edwin Lankester, M.D., F.R.S.; Isaac Byerley, Esq., F.L.S.

SECTION E.—GEOGRAPHY AND ETHNOLOGY.

President.—Sir. R. I. Murchison, D.C.L., F.R.S.

Vice-Presidents.—Sir R. H. Inglis, F.R.S.; Col. Chesney, F.R.S.; Captain Fitz-Roy, F.R.S.; Dr. Conolly, D.C.L.; Dr. Latham, F.R.S.

Secretaries.—Norton Shaw, M.D., Sec. Roy. Geog. Soc.; Richard Cull, Esq., Hon. Sec. Eth. Society; Dr. Ihne; Rev. H. Higgins, M.A.

SECTION F.—STATISTICS.

President.—Thomas Tooke, Esq., F.R.S.

Vice-Presidents.—His Grace the Archbishop of Dublin; Colonel Sykes, F.R.S.; William Brown, Esq., M.P.; R. Monckton Milnes, Esq., M.P.

Secretaries.—William Newmarch, Esq.; W. H. Duncan, Esq., M.D.; J. T. Danson, Esq.; Edward Cheshire, Esq.

SECTION G.—MECHANICAL SCIENCE.

President.—John Scott Russell, Esq., M.A., F.R.S.

Vice-Presidents.—William Fairbairn, Esq., C.E., F.R.S.; Joseph Locke, Esq., M.P.; James Nasmyth, Esq., C.E.; Rev. Professor Walker, M.A., F.R.S.; Henry Booth, Esq.; John F. Bateman, Esq., F.G.S.; Thomas Webster, Esq., M.A., F.R.S.; Col. Chesney, F.R.S.

Secretaries.—James Oldham, Esq., C.E.; John Grantham, Esq., C.E.; James Thomson, Esq., C.E.

CORRESPONDING MEMBERS.

Professor Agassiz, *Cambridge, Massachusetts.*
M. Babinet, *Paris.*
Dr. A. D. Bache, *Philadelphia.*
Professor H. von Boguslawski, *Breslau.*
Mr. P. G. Bond, *Cambridge, U.S.*
M. Boutigny (d'Evreux).
Professor Braschmann, *Moscow.*
Chevalier Bunsen, *Heidelberg.*
Prince Charles Bonaparte, *Paris.*
M. De la Rive, *Geneva.*
Professor Dove, *Berlin.*
M. Dufrénoy, *Paris.*
Professor Dumas, *Paris.*
Dr. J. Milne-Edwards, *Paris.*
Professor Ehrenberg, *Berlin.*
Dr. Eisenlohr, *Carlsruhe.*
Professor Encke, *Berlin.*
Dr. A. Erman, *Berlin.*
Professor Esmark, *Christiania.*
Professor G. Forchhammer, *Copenhagen.*
M. Leon Foucault, *Paris.*
M. Frisiani, *Milan.*
Professor Asa Gray, *Cambridge, U.S.*
Professor Henry, *Washington, U.S.*
Baron Alexander von Humboldt, *Berlin.*
M. Jacobi, *St. Petersburg.*
Professor Kreil, *Prague.*
M. Kupffer, *St. Petersburg.*
Dr. Langberg, *Christiania.*
M. Le Verrier, *Paris.*
Baron de Selys-Longchamps, *Liège.*
Dr. Lamont, *Munich.*
Baron von Liebig, *Munich.*
Professor Gustav Magnus, *Berlin.*
Professor Matteucci, *Pisa.*
Professor von Middendorff, *St. Petersburg.*
M. l'Abbé Moigno, *Paris.*
Professor Nilsson, *Sweden.*
Dr. N. Nordengsciold, *Finland.*
Chevalier Plana, *Turin.*
M. Quetelet, *Brussels.*
Professor Plücker, *Bonn.*
M. Constant Prévost, *Paris.*
Professor C. Ritter, *Berlin.*
Professor H. D. Rogers, *Philadelphia.*
Professor W. B. Rogers, *Virginia.*
Professor H. Rose, *Berlin.*
Baron Senftenberg, *Bohemia.*
Dr. Siljestrom, *Stockholm.*
M. Struvè, *St. Petersburg.*
Dr. Svanberg, *Stockholm.*
Dr. Van der Hoeven, *Leyden.*
Baron Sartorius von Waltershausen.
M. Pierre Tchihatchef.
Professor Wartmann, *Lausanne.*

REPORT OF THE PROCEEDINGS OF THE COUNCIL IN 1853–54, AS PRESENTED TO THE GENERAL COMMITTEE AT LIVERPOOL, WEDNESDAY, SEPTEMBER 20TH, 1854.

The Council has been informed that invitations to the Association will be presented to this Meeting on the part of the University and City of Glasgow; on the part of the Board of Trinity College, Dublin, for 1857, supported by the Royal Irish Academy and the Queen's University in Ireland; from Brighton; from the Mayor and City Council of Manchester; from Cheltenham; and from Ryde in the Isle of Wight.

In transmitting the accompanying reports from the Parliamentary Committee of the British Association, and from the Committee of the Kew Observatory, the Council believe that the General Committee will find in these two documents the most satisfactory evidence of the increasing public importance and general usefulness of the British Association.

In the case of the Parliamentary Committee, the Council consider themselves only as the organ through which the report of the last year's proceedings are presented to the General Committee. In the case of the Kew Committee, the members of which are also members of the Council, and act under the authorization of the Council, the report is addressed to the body from whence the authority is derived. In transmitting it to the General Committee, therefore, the Council desire to express at the same time their full concurrence in its closing recommendation. They are persuaded that if the financial position of the Association will admit of an increased grant being made to the Observatory for special purposes in the next year, no better application could possibly be made of the money, either for the benefit of science or for the credit of the Association.

The Report of the Kew Committee to the Council, signed by J. P. Gassiot, Esq., Chairman:—

In their Report for the last year your Committee stated that an application had been made to them by the Hydrographer of the Admiralty for advice as to the construction of Thermometers to be supplied to H.M. Navy, for the purpose of making meteorological observations at sea, and that your Committee had undertaken to provide a specimen of the form of instrument which they might consider most suitable.

When the necessary experiments were completed and a Model Thermometer constructed, your Committee directed that one should be sent to each of the Philosophical Instrument Makers who had been supplied with Standard Thermometers from the Observatory, requesting that they would acquaint the Committee at what price such instruments could be supplied.

The prices named by Messrs. Negretti and Zambra and by Messrs. Casella and Co. having been ascertained to be the lowest, these firms were selected by your Committee as those to whom applications should be made to furnish such thermometers when required.

The diameter of the spherical bulb of the proposed thermometer is about $\frac{4}{10}$ths of an inch; the graduation includes a range of from 10° to 130° Fahr.; the length of the thermometer is $10\frac{1}{2}$ inches; the brass scale on which the figures are stamped is raised to nearly the level of the front of the tube, which is fastened to the scale by two clips. The scale is cut away about one inch above the bulb, a stop being fixed on the copper case so as to prevent the bulb touching the bottom of the cup.

The thermometer is constructed of enameled tubing, and the divisions are etched on the stem with fluoric acid; the figures are stamped on the brass scale at every 10th degree, and each instrument is fitted to a japanned copper case with a cup surrounding the bulb, and has a distinguishing number. The cost, in consideration of the quantity ordered from the makers at one time, including the case, is 5*s*. 6*d*., and without the case 4*s*. 6*d*., for each thermometer.

On the 3rd of December 1853 your Committee requested Colonel Sabine to inform the Hydrographer of the Admiralty that thermometers according to the model described could be supplied in any quantities: a copy of the correspondence with the Hydrographer, as also with the Board of Trade, is annexed to this Report.

On the 28th January 1854 your Committee received an application from the Smithsonian Institution of the United States, through its agent, Mr. Stevens, for specimens of thermometers and barometers for marine use, as also for a standard thermometer. Mr. Stevens has since ordered one thousand thermometers for the use of the United States Navy, five hundred from each of the before-mentioned firms, and fifty marine barometers; the whole of these instruments, which will be similar to those described in this Report, will be verified by Mr. Welsh at the Observatory.

As each thermometer will undergo a rigorous examination at the Observatory, and as a table will in all cases be furnished of scale errors, which, on the terms of the agreement with the instrument-makers, are not to exceed $0^{\circ}{\cdot}6$ between 32° and 100° Fahr., nor to vary more than $0^{\circ}{\cdot}3$ within any 10°, your Committee consider that for all the purposes intended such thermometers will be found sufficiently correct, and being obtainable at a very moderate cost, they hope future observations made with such instruments will prove of essential practical and scientific value.

On the 27th March, 1854, the Board of Trade addressed a letter to the Chairman of your Committee requesting their aid in procuring barometers and thermometers for the use of the Mercantile Marine. On the 3rd of

April the Chairman replied, stating that the Committee were willing to superintend the execution of any contract which the Board of Trade might make for the supply of such instruments, in accordance with the following resolution of the Committee:—

27th March, 1854, at a Meeting of the Kew Committee of the British Association,

Resolved,—

> "That in all cases in which the Committee is called upon to assist either Her Majesty's or other governments, in the supply of meteorological instruments, it is to be understood as a principle that the contract for such supply is to be between the government requiring the instruments and the maker furnishing the same, the contract price in all cases to cover the cost of verification at Kew."

A copy of the correspondence with the Board of Trade is attached to this Report.

Barometers.—Your Committee stated in their last year's Report that in consequence of Lieut. Maury having requested their advice upon the best form of a marine barometer, the subject was under consideration; after having examined several forms of these instruments submitted for their consideration, your Committee selected one in which it is believed all the requisites for making correct observations at sea will be found to have been obtained at a very moderate cost, combining convenience and accuracy in observing, with simplicity and durability in its general construction.

The great importance as to certain conditions requisite in a good barometer induced your Committee to have the action of this instrument tested by such means as were at their command, and this was effected by Mr. Welsh (accompanied by Mr. Adie, the maker), in a voyage to Leith and back to London; subsequently the action of the instrument was further tested by Mr. Welsh in a voyage to and from the Channel Islands; the results of these trials will be seen in the following letters addressed by Mr. Welsh to the Chairman:—

"Kew Observatory, March 25, 1854.

"MY DEAR SIR,—In accordance with the request expressed by the Committee at their Meeting on the 15th instant, I sailed the same evening by the steamer 'Clarence' for Leith, in company with Mr. Adie, for the purpose of examining the action of three barometers made by him. These barometers were all of the same construction, but having the tubes contracted in different degrees, viz. in the proportions of five, ten, and fifteen minutes respectively for the time occupied by the mercury in descending to its proper level when first placed erect.

"We did not succeed in procuring a private cabin, but Mr. Turner, the commander of the vessel, kindly allowed us to suspend the instruments in his own cabin, to which we had access during the greater part of the voyage. As the weather in this passage was too calm to allow of a decided trial of the barometers, especially with regard to the *pumping* of the mercury in the tube, we returned on Wednesday the 21st by the steamer 'Leith,' in which we had engaged a private cabin. On the return voyage, the motion of the vessel was very considerable, and afforded a fair opportunity of examining the pumping. Unfortunately one of the barometers (the one contracted to 15^m) was broken in being carried on board, so that we had only the two least contracted in the tube remaining. From an examination of the observations made, I believe the following general conclusions are pretty near the truth.

"1st. Any one of the three barometers is capable of showing *at sea* the changes of pressure, with a probable error of about 0·005 inch, or at most 0·007 in.

"2nd. The tremor of a steam ship is rather beneficial than otherwise to the performance of the barometer, and (leaving the pumping out of consideration) the barometer performs rather better at sea than on land.

"3rd. For such a motion of the ship as must be very common, the amount of contraction of the tube should be greater than in any of the three barometers employed, say a contraction to 18 or 20 minutes. The *mean* amount of pumping from ten observations in the return voyage was, for the tube contracted to 5 minutes 0·064 in., and for the one contracted to 10 minutes 0·031 in.; the greatest observed being for the former 0·13 in., and for the latter 0·05 in. In order, therefore, to reduce the pumping so that the probable error of an observation from this cause may not exceed 0·01 in., the contraction should be to 20 minutes at least.

"4th. It appears to me very desirable that each ship should be furnished with *two* barometers—one for calmer weather and the other for rougher—the former having the tube contracted to 10 or 12 minutes, and the latter to about 25 minutes. This would render good observations obtainable in all states of the weather; and if occasional comparisons of the two were taken, would, besides obviating to some extent the inconvenience arising from an accident to one, afford the means of checking any changes which might occur in the zero-points of either instrument. If, however, two barometers cannot be supplied to each ship, I am disposed at present to think that a contraction to about 15 or 20 minutes would be generally the most convenient.

"The mode of suspension and the means of observation adopted in Mr. Adie's barometers seem very suitable, the spring of the suspending arm being quite sufficient. The arm should perhaps be a little longer, say 2 inches more.

"I should mention, that the two steamers were about 700 or 800 tons burden.

"I am, yours faithfully,
"J. Welsh."

"J. P. Gassiot, Esq., F.R.S.,
Chairman of the Kew Committee."

"Kew Observatory, May 25, 1854.

"My dear Sir,—In compliance with a wish expressed by the Kew Committee at their Meeting on May 3rd, I proceeded to Southampton on the 8th instant, and made arrangements for a further trial of the marine barometers in one of the South Western Railway Company's mail steamers plying to the Island of Jersey. Having been furnished by you with a recommendation from Mr. Tite to the Secretary of the Company's steamers, I was most readily provided with the best accommodation which could be got in the ship, and received every attention and assistance from Mr. Babot, the captain.

"The principal object contemplated by me in this trial, was the determination of the amount of contraction required in the tube for the prevention, within convenient limits, of the pumping of the mercury. I took with me five barometers by Adie, all of the same general construction, but differing in the amount of contraction in the tubes. They were stopped in the following proportions—5, 10, 18, 21 and 35 minutes for the times required for the mercury to sink from the top of the tube to its true height after the barometer is placed erect.

"I found, as on the previous trial to Leith, that the first two were not nearly sufficiently contracted, the amount of pumping being indeed so great that good observations could not possibly be taken with either. The pumping in the third and fourth was much more moderate, the greatest difference between the extreme readings in either having never been observed to be more than 0·02 and seldom above 0·015, thus giving 0·01 as the limit of error of an observation from this cause. The barometer No. 5 showed, of course, even less oscillation, the extreme readings not differing more than 0·01. The circumstances under which these numbers were obtained were, I believe, favourable to a just estimate of the amount of contraction necessary, as there was both in the passage to Jersey and back a considerable amount of swell, there having been on the previous day a heavy gale blowing.

"Considering that the existence of a small quantity of pumping must at all times be desirable, in order to secure a more free action of the mercury than if the barometer were suspended quite steadily, I am of opinion that barometers having their tubes stopped to about the same extent as in Nos. 3 and 4, would, on the whole, be the most generally convenient and accurate, whilst even a greater degree of contraction would do no great harm. I would, therefore, recommend that the contraction should be from about 18 to 25 minutes.

"I have both before this trial and since made a series of comparisons between the standard by Newman and these barometers. I have found that all the barometers follow the standard very consistently. There is, however, one circumstance which should be noticed, and which I have before to some extent mentioned to the Committee. The marine barometer does not act quite freely when suspended at rest. The standard barometer is always, to a certain extent, *in advance* of the marine barometer; that is, when the mercury is rising, the marine barometer is below the standard, and when falling it is above it. The amount of this retardation I find to be about 0·01 inch; and what is rather singular, it exists to about the same extent whatever the degree of contraction of the tube, although that has varied in the proportion of 1 to 7. This retardation, it should be remembered, has been observed when the marine barometer has been left quite *at rest*, a condition which will scarcely ever obtain at sea, where there will generally be, I conceive, a sufficient amount of motion to produce a certain small degree of oscillation in the column of mercury; and it is evident that so long as any oscillation at all exists, the equilibrium of the mercury will be maintained, and the reading of the instrument will show the true barometric pressure.

"J. P. Gassiot, Esq., F.R.S.,
Chairman of the Kew Committee."

"I am, dear Sir, yours faithfully,
"J. Welsh."

The barometer as now constructed is thus described by Mr. P. Adie, the maker:—

"The tube has a diameter of from 0·22 in. to 0·25 in. About 4 inches of the tube near the middle has a capillary bore in order to produce the contraction necessary to prevent inconvenient oscillation at sea from the motion of the vessel. The degree of contraction is such, that, when the barometer is first suspended, the mercury requires about twenty minutes to fall from the top of the tube to its proper level. A pipette, or Gay-Lussac's air-trap, about 2 inches long, is inserted a little below the contraction, which serves to prevent the entrance of air into the upper part of the tube, or into the capillary portion of it. The lower end of the tube, which is within the mercury in the cistern, is also contracted. With these precautions, it is believed, that when the tube has been well filled at first, it is very unlikely to become deteriorated. The mercury is necessarily boiled in the tube in the process of filling.

"The cistern of the barometer is a cylinder of cast iron, the tube being fitted into it mercury-tight by cement; a portion of the upper part of the cistern being covered with strong sheep-skin leather firmly fixed by abutting flanges. This leather has been found to be sufficiently porous to permit the free action of the air through it, but not to allow the mercury to pass without considerable pressure, to which it can never from the construction of the instrument be subjected. The cistern is filled with mercury to such a height that it can never under any circumstances of temperature or pressure be full, but always sufficiently so to prevent the lower end of the tube being ever exposed either during carriage or when in use. This renders any adjustment of the instrument when being mounted for observation unnecessary. The diameter of the cistern is about 1·3 inch. The barometer tube is protected by a cylindrical case of brass, which is screwed firmly to the upper portion of the iron cistern. The graduation is made on this brass tube and the vernier moved by a rack and pinion, the index being adjusted to the top of the mercurial column by shutting off the light, as is commonly done in standard and other good barometers: the vernier reads to 0·002 inch. The correction for the relative capacities of the tube and cistern (which is usually applied as a numerical correction varying with the height) is in these instruments included in the graduation of the scale; the scale being shortened by the amount of the correction, but divided so as to *represent* the true measurements. The correction for capacity is obtained by computation from carefully measured diameters of the tube and cistern. The zero-point of the scale is determined by comparison with a standard barometer. A thermometer, whose scale is divided on its stem, and having its bulb within the encasing brass tube, gives the temperature of the mercury. In making an observation, it is only necessary to set and read off the vernier, and to note the height of the thermometer. The instrument presents much the appearance of a mountain barometer: it is suspended in gimbals from a point a little above the middle of the tube, the rack motion being close to the point of suspension, so that the hand may rest on the supporting arm. The supporting arm is flat, of hammered brass, thin enough to give the elasticity necessary to counteract sudden jars, and is equivalent to the spring gimbals usually employed, while much simpler in its construction."

The annexed copies of the correspondence with the Hydrographer of the Admiralty and with the Board of Trade, will explain the proceedings of your Committee as to the proposed supply of these instruments for the use of Her Majesty's Navy, as also for the Mercantile Marine of this country. Your Committee have also communicated with Lieut. Maury, by whose directions the fifty barometers were ordered from Mr. Adie by Mr. Stevens, for the use of the United States Navy, all of which are to be verified at the Observatory.

Standard Barometer.—Your Committee have devoted much attention to the completion of this instrument, but many casualties have occurred during the progress of its erection. On the 13th July last Mr. Negretti succeeded in boiling and erecting a tube of *one inch* internal diameter. Considerable changes were found necessary in the original mounting of the barometer and cathetometer. These have been satisfactorily executed at the Observatory, but the instrument still requires alteration to render its performance perfect. The scale of the cathetometer has been compared with the Kew standard scale, and found not to require any correction when laid horizontally. When the two scales are compared by observing their relative lengths vertically by the telescope of the cathetometer, a perceptible error is shown, involving a correction to the measurements of the cathetometer of + 0·003 inch in a space of 30 inches. This anomalous error is, it is conceived, due to faulty construction in the cathetometer, chiefly arising from the difficulty of making the instrument accurate on the design adopted. It is, therefore, the intention of your Committee to direct that a new cathetometer should be constructed in the Observatory on more exact mechanical principles.

The number of instruments now in course of verification, under the directions of your Committee, is:—

For the U. S. Navy	1000 thermometers.	50 barometers.
„ Board of Trade..	500 „	60 „

Definition of the Boiling-Point of Water.—Your Committee, at the last meeting of the Association, were requested to furnish a report on the definition of the boiling-point of water at present adopted in this country for the thermometric scale. This has already been considered by the Commissioners appointed by Government to construct Standard Weights and Measures, and in the Report they have presented to Government during the present year, they have defined 212° upon Fahrenheit's scale to represent "the temperature of steam under Laplace's standard atmospheric pressure, or the atmospheric pressure corresponding to the following number of inches in the barometric reading, reduced to 32° F.,—29·9218 + 0·0766 × cosine (2. latitude) + (0·00000179 × height in feet above the sea)." Your Committee recommend that this definition be adopted. In accordance with this definition, the standard pressure under which the boiling-point of thermometers will have to be determined will be,—

	At 32° F.	
In London	29·905 +	(0·00000179 × height above the sea).
In Dublin	29·900	„ „
In Edinburgh......	29·893	„ „

The small additional correction for the height above the sea level included in brackets, may be, however, neglected, being insensible at any part of the three towns mentioned.

The barometric heights here given are at 32° F., and this correction must not be overlooked.

Standard Thermometers.—The graduation of standard thermometers has been continued by Mr. Welsh, and 24 instruments have been issued since the last meeting of the Association, making a total of 94 standard thermometers supplied to institutions and individuals.

The requisite apparatus for determining the errors of barometers, as well as of thermometers, by comparison with the standards at Kew, has been constructed at the Observatory, and a detailed account of the processes employed will be given by Mr. Welsh in a separate communication to the British Association.

By means of this apparatus there have been examined during the past year—For the East India Company, 40 thermometers for 20 of Regnault's hygrometers, and 4 barometers; for the Trevandrum Observatory, 8 thermometers; for Hobarton Observatory, 3 thermometers; for E. A. Middleship, St. Kitts, 5 thermometers; for the Hydrographer of the Admiralty, 16 thermometers and 4 barometers; for Messrs. Schlagintweit, 93 thermometers, 6 mountain barometers, 9 aneroid barometers, 10 ground thermometers, and 6 boiling-point thermometers.

Standard Weights and Measures.—Your Committee have reported last year that the standard weights made by M. Œrtling, under the direction of Dr. Miller, of King's College, were at that time in the hands of Prof. Miller, of Cambridge, for verification; and that the standard scale prepared by Messrs. Troughton and Simms, was with the Rev. Mr. Sheepshanks, for comparison with the standard bar in his possession. Your Committee beg to subjoin the following letter, received from Professor Miller:—

"Cambridge, 27th January, 1854.

"I beg leave to communicate to the Kew Committee the following results of the comparison of the Kew standard bar:—

"In air temp. 65°·66 Fahr. (18°·7C), pressure 29°·75 in. of mercury, reduced to the temperature of freezing water (755·64 M.M.) by a mean of 80 comparisons, the Kew standard appears to be 0·00035 gr. heavier than $\frac{7000}{5760}$ (lost standard troy pound).

"The ratio of the density of the Kew standard at freezing to the maximum density of water is 8·20357 (log. 0·9140030), its vol. at freezing = volume of 853·2866 grs. of water at maximum density.

"The density of the Kew standard is different from that which appears to be the most probable value of the density of the lost standard, consequently its error, when reduced to vacuum, differs from the error given above. In vacuo the Kew standard is 0·00655 gr. lighter than the Parliamentary standard. (Signed) "W. H. MILLER."

The Rev. Mr. Sheepshanks, in a communication with Dr. Miller, reports, as the result of 138 comparisons made at a mean temperature of 46°·78 Fahr., that the Kew standard scale is at a temperature of 62° Fahr. 0·000091 inch longer than the standard yard. Mr. Sheepshanks proposes to repeat the comparison at a higher temperature, so as to avoid any uncertainty that may exist as regards the expansion of the Kew bar.

New Stand for Out-Door Observations with Thermometers.—At the first meeting of your Committee on 12th November, 1853, they authorized Mr. Welsh to prepare a new stand for out-door observations of thermometers. This stand has been erected outside the balustrade wall, at the top of the steps leading to the north entrance of the Observatory. The thermometers are placed at a distance of 8 feet from the wall of the house, 11 feet above the ground, and 2½ feet from the nearest part of the balustrade. In this position there is a free circulation of air in all directions of the wind. The thermometers are protected from radiation by two cages with *venetian* blind sides and roofs; the sides of the cages descending to 6 inches below the bulbs. They are thus quite sheltered from rain, whilst very little interruption is offered to the free access of the air. The dimensions of the cages are as follows:—The outer is 6 feet broad, 5 feet deep, and 5 feet high; the inner cage is 3 feet broad, 2 feet deep, and 3½ feet high, leaving a space of about 18 inches between the cages. The bulbs of the thermometers are about 16 inches above the lower portion of the framework, which is quite open. Doors on the side of the stand next the entrance of the Observatory are opened when the thermometers are to be observed. The whole of the stands are painted green inside and out.

The stand contains a pair of dry and wet thermometers, graduated at the Observatory; a maximum thermometer, also constructed at the Observatory, on the principle proposed many years since by Mr. J. Phillips, the Assistant General Secretary of the Association, and described by him in the first volume of its Reports; a maximum thermometer of the recent construction of Messrs. Negretti and Zambra; a minimum thermometer, on Rutherford's principle, made by Adie of London; and a Regnault's dew-point hygrometer, with a bellows aspirator, also made by Adie: the scales of these instruments, with the exception of Negretti's maximum thermometer and Regnault's hygrometer, are divided on the tubes.

It is believed, that by the arrangements above described, a very close approximation is made towards the conditions necessary to obtaining the true temperature of the air. Meteorological observations have been made since 1st January 1854, at 6 and 10 A.M., 2, 6 and 10 P.M.

In respect to the two forms of maximum thermometers now named, it may be stated that they have both been found to perform in a very satisfactory manner; the very ingenious instrument of Messrs. Negretti and Zambra has one quality, which, as regards durability, places it above every other form of maximum thermometer, for when once well constructed, it can never get out of order; it is somewhat difficult in construction, and consequently more costly, but the observer, having first satisfied himself as to its correctness, may ever afterwards use it with confidence, relying that his register will not be interrupted by any of those annoyances to which he may have been accustomed in other forms of this instrument. The plan of Mr. Phillips is most valuable for its extreme simplicity; it is capable of greater delicacy of indication than even Negretti's, and in the hands of an observer who treats his instruments with care, will continue to perform very accurately for probably an indefinite length of time. The only case in which this form of the instrument might be found to fail, would probably be in carriage or when otherwise exposed to violence: any thermometer, having an overflow chamber at the top of the tube, can be readily converted into a maximum with the aid of a spirit-lamp, and if the instrument should by any chance get out of order, it can as easily be remedied. Any careful observer, who is not afraid to handle a thermometer, will, it is believed, find this the most convenient form of all maximum thermometers. As an instrument for general use, and in the hands of persons unskilled or careless in the use of thermometers, its expediency may however be more doubtful.

Daily Photographic Register of the Spots on the Sun's Disc.—Colonel Sabine having reported to your Committee that Sir John Herschel had suggested to him the importance of arrangements being made for a daily photographic picture of the sun's disc, showing the spots, &c., it was resolved by your Committee that the Chairman should write to Sir John Herschel to request he would favour the Committee with his views as to the importance of the object, and the best mode of carrying it into effect. The following is a copy of the reply received from Sir John Herschel:—

"32 Harley Street, April 24, 1854.

"MY DEAR SIR,—I certainly do consider it an object of very considerable importance to secure at some observatory, and indeed at more than one, in different localities, daily photographic representations of the sun, with a view to keep up a consecutive and perfectly faithful record of the history of the spots. So far as regards the general delineation of the whole disc and the marking out on it, in reference to the parallel to the equinoctial passing through its centre, the places, sizes, and forms of the spots, there would need I should imagine no very powerful telescope; quite the contrary; but it should be equatorially mounted, and ought to have a clock motion in the parallel. The image to be impressed on the paper (or collodionized glass) should be formed, not in the focus of the object-lens, but in that of the eye-lens drawn out somewhat beyond the proper situation for distinct vision (and always to the same invariable distance to ensure an equally magnified image on each day). By this arrangement a considerably magnified image of the sun, *and also of any system of wires* in the focus of the object-glass, may be thrown upon the 'focusing glass' of a camera box adjusted to the eye-end of the telescope. By employing a system of spider lines parallel and perpendicular to the diurnal motion, and so disposed as to divide the field of view into squares, say of 5′ in the side, the central one crossing the sun's centre (or rather as liable to no uncertainty, one of them being a tangent to its lower or upper limb), the place of each spot on the surface is, *ipso facto*, mapped down in reference to the parallel and declination circle and its distance from the border, and its size, measurable on a fixed scale.

"If large spots are to be photographed specially with a view to the delineation of their forms and changes, a pretty large object-glass will be required, and the whole affair will become a matter of much greater nicety; but for reading the daily history of the sun, I should imagine a 3-inch object-glass would be ample.

"The representations should, if possible, be taken daily and the time carefully noted. As far as possible they should be taken at the same hour each day, but in this climate a clear interval, occurring when it may, had better be secured early in the day.

"Three or four observatories in tropical climates, distant several hours in longitude (suppose three, at 8^h distance in longitude), each reading at, or nearly at noon, would, when the results were assembled, keep up a continual history of the solar disc.

"With regard to proper preparations of paper, or the use of collodion, &c., the photographic art is now so much advanced that no difficulty can arise in fixing upon fitting preparations, or in the manipulations necessary for multiplying them. But it would be very requisite that many impressions of each day's work should be taken and distributed, and an interchange kept up among observers.

"Yours truly,
"J. F. W. Herschel."

"*J. P. Gassiot, Esq.*"

On the 3rd of May your Committee requested Mr. Warren De la Rue to ascertain the probable cost of an apparatus suitable to accomplish the recommendations contained in the preceding letter, and it having been subsequently ascertained by Mr. De la Rue that the probable cost would not exceed £150, your Committee, on the 29th May, resolved that the Chairman should apply to the Royal Society for that sum from the Donation Fund; the application was made on the 21st of June, and on the 29th of the same month the Council of the Royal Society acceded thereto; this amount has been since placed at the disposal of three Members of the Committee, in order that the apparatus may be purchased, and certain preliminary experiments having been made, the instrument is in course of completion by Mr. Ross, optician.

On the 14th November 1853, your Committee, on the recommendation of Mr. De la Rue, engaged the services of Robert Beckley, machinist. Mr. Welsh reports most favourably as to the efficiency of Mr. Beckley's services, not only in respect to his great ingenuity and accuracy as a workman, but also as to the interest and intelligence with which he has entered into and assisted him in the general work of the Observatory. He resides with his wife in the building, receiving weekly wages of 35*s*., which sum includes the payment to his wife as housekeeper.

Ground contiguous to the Observatory.—In accordance with the recommendation contained in their last Report, your Committee have had several interviews with the Chief Commissioner of Woods, Forests, and Land Revenue, with the view of obtaining the temporary use of about two acres of the land immediately adjoining the Observatory. Your Committee ascertained that the entire park round the Observatory was let at a yearly rental, and they were informed that it was necessary they should make arrangements with the tenant previous to permission being granted to them to use the lands; the Honourable Mr. Gore, the Chief Commissioner, at the same time expressing his anxious desire to afford every facility to the Committee.

In reply to an application of the Committee, the tenant offered the use of the land at the rate of £20 per acre. Your Committee, feeling they could not make any reply to such a demand, requested their Chairman, in conjunction with Mr Hutton, to wait on Mr. Gore, who kindly appointed a day to meet the tenant and the Committee at the Observatory. It was subsequently arranged that for the present season, viz. until next October, the tenant should receive at the rate of £7 10*s*. per acre, and for the subsequent year £10 10*s*. per acre, at which period his present term with the Crown expires.

Two acres of the land have been enclosed with a strong wooden paling preparatory to the erection of a wooden tower, under the superintendence of Mr. De la Rue, for mounting the Huyghenian object-glass, as recommended by the British Association.

The cost of enclosing the land, the rent to October 1855, as well as the erection of the wooden tower, will be chiefly defrayed from funds supplied by the Royal Society for the erection of the Huyghenian telescope, from the annual Government Grant placed at its disposal: but your Committee earnestly recommend that an immediate application should be made by the Council of the British Association for the future gratuitous use of this small portion of the park, which will be found absolutely necessary for purposes now carried on and contemplated at the Observatory; while the very limited amount of funds which the Association can annually place at the disposal of your Committee, renders such an amount for rent, which they would be compelled to pay, of considerable importance.

The daily increasing work in the Observatory, arising from the verification of meteorological instruments, as well as the probable necessity for other experimental purposes, renders it advisable that further assistance should be obtained; a portion of the increased expense that will be thus incurred, your Committee anticipate will be obtained from the amount to be received for the verification of the instruments, viz. 10*s*. for each barometer, and 1*s*. for each thermometer.

Your Committee consider that the present yearly stipend received by Mr. Welsh ought to be increased. It is impossible for them to report in sufficiently strong terms the high opinion they entertain of this gentleman's services; but all who have visited the Observatory can bear witness, not only as to the efficient manner with which he has carried out the various duties your Committee have from time to time suggested, but the zeal and untiring energy he has always evinced in the promotion of science, and in the furtherance of those objects for which he was originally appointed by the British Association.

Considering the variety and importance of the objects which are now being carried out at the Observatory, the Committee submit for the consideration of the Council, that should the financial state of the Association at Liverpool justify an increase in the annual sum placed at the disposal of the Committee, they feel confident that a larger grant than has been allowed in the last few years for the maintenance of the Observatory, might be so appropriated in the next year with great advantage to the interests of science and to the credit of the Association.

JOHN P. GASSIOT,
By order of the Committee. *Chairman.*

Dr. *The Kew Committee in account with the British Association.* **Cr.**

	£	s.	d.
Balance from Treasurer's Account, 1852	95	15	4
Grant of 1852, at Belfast	200	0	0
Grant of 1853, at Hull	200	0	0
	£495	15	4

	£	s.	d.
Payments from 1852 to 1853, details previously audited	160	10	2
Payments, detailed below, from Sept. 7, 1853, to Sept. 20, 1854	310	12	0½
Balance to be carried to next Account	24	13	1½
	£495	15	4

Detail of Payments from 7th September 1853, to 20th September 1854:—

	£	s.	d.
Porterage	3	5	5
Charwoman	9	13	0
Petty Expenses	4	13	3½
Sundry Bills, materials purchased, &c.	10	12	8
R. Beckley, Wages, Nov. 14, 1853, till Sept. 18, 1854, 44 weeks	77	0	0
Tools, Instruments and Apparatus	17	9	7
Postage Stamps	2	0	0
Stationery, Books, Printing	10	19	9
Carpenters' Bills	26	8	1½
Chandlery, &c.	13	14	10
Coals	17	0	0
Ironmonger	5	15	4½
Plasterer	1	3	6
Plumber	0	16	6
Observer's Salary, One Year	100	0	0
Allowance for Petty Travelling Expenses, &c.	10	0	0
	£310	12	0½

I have examined the above Accounts, have compared the items with the documents furnished, and find the balance to be Twenty-four pounds thirteen shillings and one penny halfpenny.

R. HUTTON.

Correspondence.

(Copy.)

"Office of Committee of Privy Council for Trade,
Marine Department, 27th March 1854.

"SIR,—I am directed by the Lords of the Committee of Privy Council for Trade, to address you as the Chairman of the Committee nominated by the British Association for the Advancement of Science to superintend the Kew Observatory; and to state that for the purpose of aiding in carrying into effect the proposed plan of making an extensive record of meteorological observations, My Lords contemplate that they shall have occasion to provide fifty barometers and three hundred and eighty thermometers, with both Fahrenheit and Centigrade Scales, and also one hundred and twenty wet bulb thermometers similarly graduated.

"It is of the highest importance that the instruments to be provided should be correct, and should bear upon them a stamp indicating that they have undergone an inspection and have been compared with an approved standard.

"My Lords would therefore be greatly obliged if the Committee of the British Association could aid them with their valuable assistance in accomplishing the purpose they have in view, and they would also be glad to be informed whether hydrometers with the graduated scale, and other instruments referred to in the report of the conference held at Brussels last year, could be tested at the Observatory.

"Their Lordships desire me to express their hope that the Committee will consider the object they have in view a sufficient apology for the step they have taken in making this application.

"I have the honour to be, Sir,
"Your obedient Servant,
"J. P. Gassiot, Esq." (Signed) "T. H. FARRER."

(Copy.)

"Clapham Common, 3rd April 1854.

"SIR,—In reply to your letter of 27th March I have been directed to inform you, that for the purpose of forwarding a matter which is likely to prove of so much importance to the maritime interests of this country, the Kew Committee of the British Association are quite ready to superintend the execution of any contracts which the Board of Trade may make for the supply of thermometers and barometers.

"The Committee recommend that the same form of thermometers should be used for examining the temperature of the air, the sea, and aqueous vapour. The Committee have prepared a specimen of the thermometer approved by them for the purpose of taking observations at sea; this thermometer is divided in Fahrenheit degrees, and the Committee are of opinion that very great inconvenience, and a considerable sacrifice in accuracy, would result from any attempt to combine both the Fahrenheit and Centigrade scales on the same instrument. They are also of opinion that no advantage whatever would be gained by such a combination.

"A barometer has been selected, and its action tested by Mr. Welsh in a trip to Leith and back to London in a steamer; some slight alterations in its construction are being made, and in the mean time, application has been made to the Admiralty to have its action tested in a short cruise in the Channel, or North Sea, in order that its freedom from pumping, and convenience of reading may be judged of, and reported thereon by officers in H.M. Navy experienced in such observations.

"It is proposed by the Committee that the instruments shall be supplied at a fixed price, which for the barometer the Committee expect will be about £3 10*s*., and for the thermometer not exceeding 6*s*. each.

"In order to fulfil the conditions necessary to ensure the required accuracy, the Committee will prepare a memorandum of conditions to which each instrument-maker will be bound to accede in accepting the contract, and the price will include every expense of verification.

"On the return of any vessel which may be supplied with these instruments, the Committee will be ready to examine the errors, for which a small fee will be charged to cover the expense incurred.

"In respect to hydrometers recommended in the Brussels report, the Committee suggest for the consideration of the Board of Trade, whether any advantage could be obtained by their general use at sea.

"The Committee suggest that all contracts should be made by the Board of Trade with the instrument-maker, the prices being first fixed by the Committee, and which will include every expense of verification at Kew; and it is proposed that each instrument shall be stamped with a consecutive number.

"Should the above arrangements meet the approval of the Board of Trade, the Committee will be ready to forward a barometer and thermometer of the construction which they consider best adapted for the objects intended, and Mr. Welsh, whose especial duty it will be to compare each instrument before it is delivered to the Board of Trade, will be happy to wait on you at any time you may appoint.

"I have the honour to be, Sir,
"Your obedient Servant,
(Signed) "JOHN P. GASSIOT."

"To T. H. Farrer, Esq.,
Secretary Marine Department, Board of Trade."

P.S. Should it be the wish of the Board, the Committee will readily take into consideration and recommend in a similar manner as they have the other instruments, a proper hydrometer suitable for ascertaining the specific gravity of sea water.

(Copy.)

"Office of Committee of Privy Council for Trade,
Marine Department, 6th April, 1854.

"SIR,—I am directed by the Lords of the Committee of Privy Council for Trade to request you to convey to the Committee of the British Association for conducting experiments at Kew, their best thanks for the prompt and satisfactory manner in which the Committee have acceded to their Lordships' wishes as expressed in my letter of the 27th ultimo.

"I am to state that My Lords will avail themselves of the proposal of the Committee, and as it is desirable that no time should be lost in procuring the instruments in question, they will be obliged if the Committee will send a specimen of each of the instruments they approve (including an hydrometer) to the Board of Trade.

"My Lords coincide in the opinion expressed by the Committee that much inconvenience may in the onset arise from the attempt to combine in thermometers the Fahrenheit and Centigrade scales, and they would therefore wish that the present supply should have the Fahrenheit scale only.

"I am, Sir,
"Your obedient Servant,
(Signed) "T. H. FARRER."

"J. P. Gassiot, Esq."

(Copy.)

"Clapham Common, 10th April, 1854.

"SIR,—I beg to acknowledge the receipt of your letter of 6th inst.

"I have given instructions for a thermometer constructed under the superintendence of the Kew Committee, and recommended by them for adoption by the Board of Trade, to be forwarded to you for inspection.

"The instrument-makers selected by the Committee for the supply of thermometers are Messrs. L. P. Casella and Co., 23 Hatton Garden, and Messrs. Negretti and Zambra, 11 Hatton Garden, to whom the Committee have addressed letters, copies of which I annex, as also of the replies which the Committee received.

"The Committee are of opinion that the sum of one shilling per thermometer will cover the cost of verification at Kew, and this sum must therefore be added to whatever tender the Board of Trade may accept.

"No arrangement has been made by the Committee for the cost of packing, or the carriage of the instruments to and from the Observatory for verification.

"The barometer selected by the Committee has been constructed by Mr. Adie, of the Strand; its action has been tested by Mr. Welsh, but in consequence of suggested improvements, arrangements have been made for a further trial. In a few days the Committee will be enabled to forward the instrument for inspection, together with every information as to its probable cost.

"The Committee have given instructions for the construction of the hydrometer, suitable for the purpose of taking the specific gravity of sea water, and on receiving the instrument from the makers will forward it to you, with an estimate of the cost of its construction.

"T. H. Farrer, Esq." (Signed) "JOHN P. GASSIOT."

(Copy.)

"Clapham Common, 10th April, 1854.

"DEAR SIR,—At a meeting of the Kew Committee held this day, it was resolved, that the offer of Mr. Clutton, for the temporary use of about two acres of the land immediately contiguous to the Observatory, and to be used for Meteorological and Astronomical purposes, should be accepted at the rate of £10 10*s*. per acre; such rent to commence from 25th of last March. It is also understood by the Committee, that the amount of any damage sustained by the cartage of materials for the erection of any buildings required by the Committee, is to be referred to Mr. Clutton, by whose decision the Committee will be bound. I am desired by the Committee to express to you their thanks for the kind and prompt manner in which you have always received their applications, and particularly for the personal trouble you took in visiting their Observatory, for the purpose of ascertaining the precise requirements of the Committee.

"I have the honour to be, dear Sir, yours truly,

"To the Hon. Charles Gore." (Signed) "JOHN P. GASSIOT."

(Copy.)

"Office of Committee of Privy Council for Trade: Marine Department,
"2187. 20th April, 1854.

"SIR,—I am directed by the Lords of the Committee of Privy Council for Trade to acknowledge the receipt of your letter of the 10th instant, with the inclosures from Messrs. Casella and Company, and Messrs. Negretti and Zambra, and I am to request that you will convey to the Kew Observatory Committee of the British Association their Lordships' thanks for the information therein contained. "I am, Sir, your obedient Servant,

(Signed) "T. H. FARRER."

"John P. Gassiot, Esq."

(Copy.)

"Clapham Common, 2nd June, 1854.

"Sir,—In reference to my letter of 3rd April, I have now to acquaint you, that the Committee have decided on the barometer which they consider most applicable for marine observations, one of which I forward for inspection.

"In selecting the form of marine barometer best adapted to the purpose of making observations at sea, the Committee have endeavoured to combine convenience and œconomy with accuracy, durability, and simplicity in construction and adjustments. A barometer which has been constructed by Mr. Adie appears to them to fulfil those conditions in a satisfactory manner. Its action at sea has been tested under their superintendence by Mr. Welsh on two occasions, one on a voyage to Leith and back, and subsequently to the island of Jersey. The general conclusion arrived at in those trials is, that in order to reduce the pumping of the mercury within convenient limits, it is necessary to have the tube contracted to such an extent that the mercury will take about twenty minutes to fall from the top of the tube to the height indicating the true pressure of the atmosphere at the time. From comparisons made at Kew with the standards there, it has been found that owing to this contraction in the tube the absolute freedom of the mercury is to a small extent interfered with; as the motion of the mercury in the standard barometer is always a little in advance of the marine barometer; that is, when the mercury is rising, from increasing pressure of the atmosphere, the marine barometer is a little lower than the standard, and, on the contrary, when the mercury is falling, the marine barometer is a little higher. The amount of this retardation is however very small, something less than $\frac{1}{100}$th of an inch, and from its being in opposite directions in a rising and falling barometer, will produce no error in the *mean* height of the barometric column; it will, however, to some extent mark the smaller changes, such as the hourly variations. It should be remarked, however, that the motion of the ship will always tend to diminish the amount of the retardation, and it is believed will in general nearly destroy it.

"The instrument is constructed by Mr. Adie, of 395 Strand; the price, including cost of packing-case, 10*s.* for verification at the Observatory, carriage there, and subsequent delivery in London, will be 3*l.* 15*s.* 6*d.*, at which price Mr. Adie is prepared to supply any quantity that may be required. "I have the honour to be, Sir, your obedient Servant,

"T. H. Farrer, Esq., Board of Trade." (Signed) "John P. Gassiot."

(Copy.)

"Clapham Common, 2nd June, 1854.

"Sir,—I am instructed by the Committee of the British Association to acquaint you, that after much consideration they have selected and decided on a barometer which they consider applicable for marine observations.

As to Mr. Farrer, 2nd June.

"The Committee suggest, that it might be advisable that the barometer should be also tested at sea by an officer of H.M. Navy, qualified to judge of the suitability of the instrument for the objects contemplated.

"The barometer is constructed by Mr. Adie, of 395 Strand: the price, including the cost of packing-case, 10*s.* for verification at the Observatory, carriage there, and subsequent delivery in London, will be 3*l.* 15*s.* 6*d.*

"I have the honour to be, my dear Sir, yours obediently,

(Signed) "John P. Gassiot,
"Chairman of Kew Committee,
British Association."

"Sir F. Beaufort, F.R.S., Hydrographer,
&c. &c. &c. Admiralty."

(Copy.)

"Hydrographic Office, Admiralty, 3rd June, 1854.

"DEAR SIR,—In acknowledging your favour of yesterday's date, I have to request that you will convey my thanks to the Kew Committee of the British Association for that satisfactory communication, and that I am glad to learn that a marine barometer has at length been constructed which is likely to fulfil so many useful conditions.

"In order to carry into immediate execution the suggestions of the Kew Committee, I would beg the favour of your directing Mr. Adie to supply this office, without delay, with one of those instruments.

"I have the honour to be, Sir,
"Your most obedient Servant,
(Signed) "F. BEAUFORT,
"Hydrographer."

"John P. Gassiot, Esq., Chairman of Kew Committee,
Clapham Common."

(Copy.)

"Office of Committee of Privy Council for Trade:
Marine Department, 8th June, 1854.

"3214.

"SIR,—I am directed by the Lords of the Committee of Privy Council for Trade, to acknowledge the receipt of your letter of the 2nd instant, and of the pattern barometer upon which the Kew Observatory Committee of the British Association have decided as most applicable for marine observations; and I am to acquaint you, that My Lords will avail themselves of the arrangements which the Committee have been so good as to make with the several instrument-makers, as soon as they are prepared to give the order for a supply.

"I am, Sir,
"Your obedient Servant,
"T. H. FARRER."

"J. P. Gassiot, Esq."

REPORT OF THE PARLIAMENTARY COMMITTEE OF THE BRITISH ASSOCIATION TO THE MEETING HELD AT LIVERPOOL IN SEPTEMBER 1854.

The Parliamentary Committee have the honour to report as follows:—

The subjects to which the attention of the Committee has been directed since their last report, are—

1st. Lieut. Maury's scheme for the improvement of Navigation.

2nd. The conditions on which pensions are now bestowed on men of science.

3rd. A correspondence which they have commenced with various eminent cultivators of science on the question,—Whether it might be possible to improve the position of science or its cultivators in this country by any measures to be adopted by Government or Parliament.

4th. The proposed juxtaposition of the scientific societies in some central locality of the metropolis.

As to the first,—

The Chairman and Mr. Heywood have had interviews with the President, the Vice-President and Officers of the Board of Trade on this subject, and Mr. Heywood has on two several occasions addressed some remarks to the House of Commons thereon; and the Committee have great pleasure in reporting, that Government have now established a department in the Board of Trade, with the view of carrying out in every particular the recommendations of the Royal Society and this Committee, in reference to this important scheme for improving navigation, and accumulating meteorological data to an extent far surpassing anything which has hitherto been attempted. The Government have also appointed Capt. Robert FitzRoy, R.N. to be at the head of this new department, which is in itself a guarantee that it will successfully carry out all the important objects for which it has been established.

Scientific officers of the navy and mercantile marine will now feel assured that the records of their valuable observations and surveys will no longer slumber neglected amidst the dust of offices, but be reduced and rendered available to science and mankind without any unnecessary delay. The sum voted for the new department by the House of Commons for the present year is £3200, but there can be no doubt that this sum will be augmented in future years, if the expectations that we have been led to form as to the inestimable public benefits likely to flow from the labours of this office shall be realized.

Captain FitzRoy has since his appointment been employed in superintending the construction of instruments, printing forms, and selecting agents at the outports. Some ships will be supplied with instruments in October, and Captain FitzRoy expects that the new office will be fully organized in the succeeding month.

The following correspondence relates to the second subject above-mentioned:—

"14th March, 1854.

"My Lord,—As Chairman of the Parliamentary Committee of the British Association appointed for watching over the interests of science, I have been requested to address you on a subject of great importance to those interests.

"Your lordship is probably not aware, that soon after the accession of the late Government to power, Sir Robert Inglis and myself solicited and obtained an interview with Lord Derby, in which we represented to him that considerable dissatisfaction prevailed among the cultivators of science generally at the bad success which had attended certain then recent applications for pensions to some eminent scientific individuals, which had been preferred by the President of the Royal Society, and by subsequent investigations it was ascertained (and I communicated the fact to Lord Derby by letter dated in April 1852), that since the accession of Her Majesty about thirteen per cent. only of the annual sum allowed by Parliament to be granted for pensions to deserving persons had fallen to the lot of science, a result which naturally contributed to increase that feeling of dissatisfaction, to which I have already adverted.

"It appears that a recent application by Lord Rosse of a similar character has been unsuccessful, and that your lordship in declining to accede to it expressed yourself as follows:—'In order to meet even a small portion of the claims preferred to me, I have been compelled to require that poverty should be the attendant of merit; and that the pension should be as much the relief of pecuniary distress as the acknowledgment of intellectual attainments.' Lord Rosse could not of course consider a letter from your lordship on a subject of vital importance to science in the character of a private communication; and as that subject had already been referred to the consideration of our Committee, of which he is an influential member, a copy of your lordship's letter was laid before it.

"Now whatever our individual opinions may be on the merits of the particular case to which I have alluded, I purposely abstain from stating them, in order that the object of the present address may not be misunderstood,—that object being, to represent to your lordship, with all that respect which is justly due both to yourself and to the high station which you occupy, that the views above expressed as to the disposal of the pension fund, would render absolutely nugatory, so far as science and its cultivators are concerned, all the benevolent intentions which Parliament and the country must be supposed to have entertained in their favour when the provision in question was created.

"That the grant of a pension would be an inappropriate method of recompensing scientific merit when possessed by those who may be properly termed *rich*, I am not disposed to deny; but if it were hereafter to be understood that the receipt of a pension from the Crown were full as much the indication of absolute poverty, as an acknowledgment of high intellectual attainment, we apprehend that the object of the grant would be hereafter but ill attained.

"Had such a view of the intention of Parliament been formally announced, the honoured names of Airy and of Owen, of Hamilton and Adams, would never have appeared on the pension list; and that small encouragement to abstract science which has hitherto been dispensed by the British Government, would virtually have been withdrawn;—the bounty of Parliament and the Crown would have been looked upon in the light of alms, and men of eminence would not have consented to be paraded before the public as its needy recipients. Considering your lordship's known appreciation of the claims of literature, and we hope we may also add of science, upon a nation which depends so essentially for its prosperity and even safety upon the progress of improvement in every branch of intellectual exertion, I cannot but express on my own part, and on that of my colleagues, our earnest hope that your lordship will reconsider your views of the object of pensions, and refrain from exacting conditions for their enjoyment which cannot be otherwise than painful to all who have a high sense of the dignity of their pursuit, and may possibly be considered as tending to degrade it.

"I remain, &c., "WROTTESLEY."

"To the Earl of Aberdeen, &c."

"Downing Street, March 29th, 1854.

"MY LORD,—The letter which I addressed to Lord Rosse in October last, in answer to an application from several distinguished scientific men for a pension of two hundred a year to Professor Phillips, was intended rather as a private explanation of the motives which had practically regulated my distribution of the Civil List Pensions, than as laying down any fixed principle on the subject. But, with the greatest respect for your Lordship's Committee, and after fully considering the matter, I do not know that I can materially qualify the statement made by me to Lord Rosse.

"It has been my endeavour, as much as possible, to appropriate these Pensions to persons more or less connected with science or literature, or to their families; but the vote of the House of Commons would include a much wider range. The general belief that these Civil List Pensions were intended by Parliament exclusively for science and literature is altogether incorrect; and it is right that this should be clearly understood.

"The following are the terms of the Act, by which the Queen was enabled 'to grant pensions not exceeding £1200 in any one year, to such persons only who have just claims on the Royal beneficence, or who by their personal services to the Crown, by the performance of duties to the public, or by their useful discoveries in science and attainments in literature and the arts, have merited the gracious consideration of their sovereign, and the gratitude of their country.'

"It is obvious that the whole sum of £1200 might very easily be expended according to the terms of the Act, without any portion of it being appropriated to science and literature. Indeed, this great latitude has occasionally led to the insertion of names in the list which we scarcely might have expected to find there.

"Nothing would afford me more pleasure than to have the power of distributing a sum equal to the amount of all the Civil List Pensions, as an acknowledgment of scientific merit. There are three or four persons whose names I should be most anxious to include in such a distribution; but under present circumstances, I am prevented from doing so by want of means.

"On the whole then, and without making any resolution which should preclude me from exercising a discretion on the subject according to the circumstances of the case, I am still disposed to think that, as a general rule, the practice I have followed must be considered as most extensively beneficial.

"I have the honour to be, &c.,

"The Lord Wrottesley." "ABERDEEN."

As to the third subject above adverted to, the Chairman, with the sanction of the Committee, has addressed the following question to several distinguished men of science—Whether any and what measures could be adopted by the Government or the Legislature to improve the position of science and of its cultivators in this country? Several answers containing suggestions of great value and interest have been already received, and when the results of the inquiry have been embodied in a report, it will be communicated to the General Committee.

4th. The Royal Society Council having referred the question of the proposed juxtaposition of scientific societies to your Committee, the Chairman, together with several members of the Committee, accompanied a deputation to Sir William Molesworth, the Chief Commissioner of Works (to whom they had previously sent particulars of the amount of accommodation the principal scientific societies would require), on the 8th of July last; Sir William Molesworth however stated, that he had no actual authority to make any offer to the deputation of any part of the site of Burlington House. Some discussion took place on the various questions involved in this arrangement, and Sir William intimated his opinion, that the societies already occupying apartments in Somerset House had peculiar claims on the Government, and would have a preference in the allocation of the site.

The Chairman availed himself of the opportunity afforded by the discussion of the Oxford University Bill in the House of Lords, to make some observations on the neglect of the study of Physical Science at that University, and it is indeed much to be regretted that the rewards held out as an inducement to the study of science in that University should be so insignificant in amount, and, secondly, that *some* knowledge at least of the laws and phænomena of nature is not required as a necessary preliminary to a degree: these studies are in themselves so attractive to the generality of minds, that the mere admission within the vestibule of science often leads to a successful exploration of its inmost recesses:—and could the Universities be induced to adopt this suggestion, our public schools would be compelled to teach it, its ranks would be immediately reinforced by a corps of zealous worshipers; and an increased demand would arise for professors, whose emoluments would furnish an additional stimulus to the prosecution of these delightful and soul-exalting pursuits.

The General Committee will hear with regret that Sir Robert H. Inglis, having retired from Parliament, has ceased to be a Member of this Committee. Your Committee recommend that Mr. John Ball, M.P. for the county of Carlow, who is both an old Member of the British Association and well known as a cultivator of natural science, be appointed to succeed him.

Your Committee cannot take their leave of their late colleague without an expression of their grateful thanks for the zealous and valuable assistance which he afforded to them when his cooperation was invited; and when the Committee call to mind the various occasions on which he has supported the interests of science in the legislature, they cannot but consider that by the retirement of Sir R. H. Inglis from Parliament, science has lost therein a zealous advocate and a sincere friend.

13th September, 1854. WROTTESLEY.

RECOMMENDATIONS ADOPTED BY THE GENERAL COMMITTEE AT THE LIVERPOOL MEETING IN SEPTEMBER 1854.

[When Committees are appointed, the Member first named is regarded as the Secretary of the Committee, except there be a specific nomination.]

Involving Grants of Money.

The Committee having had under consideration the Report of the Council accompanied by the Report of the Kew Committee, which describes their Proceedings during the past year, have the satisfaction of expressing their full concurrence in the views and proceedings recorded in those Reports; and having learned that to meet special charges in the current year, a large grant will be required; resolved—

That the sum of £500 be placed at the disposal of the Council, for the maintenance of the Establishment at Kew.

That the Committee appointed in 1852 for the investigation of the Physical Aspect of the Moon, be re-appointed, and requested to continue their labours; with £25 at their disposal for the purpose.

That Mr. Mallet be requested to continue his researches as to the best method of determining instrumentally the direction, intensity, and time of Earthquakes; with £50 at his disposal for the purpose.

That Professor Phillips and Professor A. Ramsay be requested to construct a tabulated drawing of the various geological strata, for use in the Geological Section; with £15 at their disposal for the purpose.

That £100 be contributed in aid of the publication of the late Mr. Hugh E. Strickland's Manuscript Work on Ornithological Synonyms.

That Dr. Lankester, Professor Owen, Dr. Dickie, and Dr. Laycock be a Committee for drawing up Tables for the registration of periodic phænomena; with £10 at their disposal for the purpose.

That Dr. Daubeny, Dr. Lindley, and Professor Henslow be requested to continue their experiments on the Vitality of Seeds; with £11 at their disposal for the purpose.

That Professor Henslow, Professor Phillips, Sir Wm. Jardine, Mr. C. C. Babington, Prof. E. Forbes (since deceased), Professor Balfour, Professor Owen, Dr. Hooker, Mr. J. Scott Bowerbank, Rev. M. J. Berkeley, Dr. G. Johnston, Mr. Huxley, and Dr. Lankester, be requested to draw up a Report on the best manner of selecting and arranging a series of Typical Objects illustrative of the three kingdoms of Nature, for provincial Museums; with £10 at their disposal for the purpose.

That Mr. Patterson be requested to continue the dredging operations in the neighbourhood of Belfast; with £10 at his disposal for the purpose.

That the grant of £15, to provide a large Outline Map of the World, for the use of Section E., be renewed, and that the President of Section E., Sir Roderick Murchison, be requested to obtain such a Map as the Section requires.

That the sum of £5 be granted for the purpose of sending out the Ethnological questions, and that Dr. Conolly and Mr. Cull be the Committee for that purpose.

Applications to Government or Public Institutions.

That application be made by the President and Officers to Her Majesty's Government for the use, rent-free, of Two Acres of Ground, adjacent to the Kew Observatory, when the present lease expires, and for the laying on of Gas for the use of the Establishment.

That application be made to the Master-General of the Ordnance for the early publication of a Table of the Heights determined by the Trigonometrical Surveys of the United Kingdom; and that the said Table be accompanied by a statement of the levels of the sea taken as the base of the observations now in progress in England, in Scotland, and in Ireland; of the places where taken; and of the reasons for the selection of the same respectively.

That the Dean of Ely, the Astronomer Royal, Sir J. F. W. Herschel, Col. Sabine, Col. Sykes, Mr. Gassiot, Professor Miller, and Mr. Hopkins, be appointed a Committee for considering the propriety of repeating the Balloon Experiments of 1852, and of applying to the Royal Society for the grant of the necessary funds.

That in reference to the Expedition to North Australia, which has been so long contemplated, and for which a Parliamentary grant was voted last Session, an application be made to Her Majesty's Government, that the arrangements for its prosecution be completed with all convenient despatch; and that a deputation, consisting of Sir R. Murchison, Dr. Conolly, Dr. Latham, and Dr. Shaw, be appointed to wait on His Grace the Duke of Newcastle, to represent the wishes of the Association.

That it is expedient, for the advancement of our knowledge of Naval Architecture, that a portion of the intended Museum at Liverpool should be appropriated to this subject.

That Mr. W. Fairbairn, Mr. J. Nasmyth, and Mr. J. Whitworth, be a Committee for taking the necessary steps for instituting an inquiry into the causes of Boiler Explosions.

That the Earl of Harrowby, the Dean of Ely, Col. Sabine, Prof. Graham, Mr. W. Fairbairn, and Mr. T. Webster, be a Committee for the purpose of taking such steps as may be necessary to render the Patent system of this country, and the funds derived from inventors, more efficient and available for the reward of meritorious inventors and the advancement of practical science.

The General Committee having learnt, in the progress of this Meeting, that great differences of opinion prevail in the port of Liverpool regarding the navigation of iron ships, and that great inconvenience and loss have been experienced in consequence of the errors occasioned in the compass by the iron of the ship, recommend to the shipowners and other gentlemen interested in navigation at Liverpool, to form a committee for the purpose of considering the question, and making such representations to Her Majesty's Government as may appear necessary, and of offering any suggestions which they may think desirable.

That Mr. Henderson and Col. Chesney be a Committee for the purpose of collecting the statistics of the design, arrangement, and dimensions of Life-boats.

Not Involving Grants of Money or Application to Government.

PARLIAMENTARY COMMITTEE.

The General Committee are desirous of expressing their thanks to the Members of the Parliamentary Committee for the valuable services which they have rendered to science since the last meeting of the Association: the establishment of a department of the Board of Trade, under the superintendence of Captain Robert FitzRoy, so well known as a scientific navigator, for collecting meteorological and other observations at sea, and for promptly discussing and disseminating the information which they afford, in conjunction with the corresponding system of Lieut. Maury, which has been in operation for several years in the United States, is likely to prove of the most important benefit to the interests of navigation and commerce: and the Committee gladly avail themselves of this opportunity of acknowledging the support which this great and wise measure has received from the able and persevering advocacy of Lord Wrottesley and Mr. James Heywood; and they beg also to notice with particular satisfaction the important aid which is likely to be afforded to the successful operation of this system of observations by the Observatory at Kew, and its indefatigable superintendent Mr. Welsh.

The Committee sincerely join in the general feeling of regret which has been expressed at the retirement from Parliament of Sir Robert Harry Inglis, who was on every occasion ready to throw the influence of his high public and private character in favour of every project which was calculated to advance the cause of science and humanity.

The following Resolutions were adopted in reference to the Parliamentary Committee:—

That any Member of the Parliamentary Committee who shall not have attended any one Meeting of that Committee for the space of two years, shall be considered as having resigned, but shall be eligible for re-election, and the vacancy so caused shall be supplied in the same manner as vacancies now occurring are directed to be supplied.

That John Ball, Esq., M.P. for Carlow, be elected a Member of the Parliamentary Committee *vice* Sir R. H. Inglis, Bart., who has retired from Parliament.

Applications for Reports, &c.

That Mr. Robert Hunt be requested to continue his researches on the Chemical Action of the Solar Rays.

That Dr. Hodges of Belfast, and Dr. Gladstone, F.R.S., be requested to continue their respective researches on Flax Fibre and on Solar Radiation, and report thereon.

That Dr. T. Anderson, F.R.S.E., be requested to furnish a report to the next Meeting on the Progress of Chemical Manufactures in Glasgow.

That Prof. Williamson, Ph.D., be requested to report on Recent Researches on Chemical Affinity.

That Prof. Miller, M.D., be requested to report on the recent progress of Electro-Chemistry.

That Mr. P. P. Carpenter be requested to draw up a report on the present state of our knowledge with regard to the Mollusca of California.

That Mr. Fairbairn be requested to continue his Experiments on the strength of Wrought-iron plates at different temperatures.

That the Committee, consisting of Mr. James Thomson, A.M., C.E., Belfast, and Mr. William Fairbairn, C.E., F.R.S., be requested to continue their Experiments on the Friction of Discs in Water, and on Centrifugal Pumps.

That a Committee, consisting of the Earl of Harrowby, Admiral Beechey, Mr. Joseph Brooks Yates, Mr. Joseph Boult, Sir R. I. Murchison, and Mr. George Rennie, be appointed to investigate and report upon the effects produced upon the channel of the Mersey by the alterations which within the last fifty years have been made in its banks;—Mr. Boult to be Secretary of the Committee.

That Mr. John Scott Russell be requested to prepare a report on the present state of our knowledge of Naval Architecture.

Printing of Communications.

That the Paper by Mr. W. G. Armstrong, F.R.S., on Various Applications of Water-pressure Machinery, be published *in extenso* in the Report.

That a Communication by Mr. Follett Osler, entitled "Description of the Anemometer erected at the Observatory," with report on the Observations made therewith, be printed entire in the volume for this year.

Synopsis of Grants of Money appropriated to Scientific Objects by the General Committee at the Liverpool Meeting in Sept. 1854, *with the name of the Member, who alone, or as the First of a Committee, is entitled to draw for the Money.*

	£	s.	d.
Kew Observatory.			
At the disposal of the Council for defraying Expenses	500	0	0
Mathematics and Physics.			
ROSSE, EARL OF.—Physical Aspect of the Moon	25	0	0
Geology.			
MALLET, Mr. R.—Earthquake Movements................	50	0	0
PHILLIPS, Prof. John.—Tabular Views of Strata	15	0	0
Zoology and Botany.			
At the disposal of the Council—For Ornithological Synonyms	100	0	0
LANKESTER, Dr.—Periodical Phænomena................	10	0	0
DAUBENY, Dr.—Vitality of Seeds	11	0	0
HENSLOW, Prof.—Typical Objects for Museums	10	0	0
PATTERSON, Mr. R.—Dredging near Belfast..............	10	0	0
Geography and Ethnology.			
MURCHISON, Sir R.—Map of the World.................	15	0	0
CONOLLY, Dr.—Ethnological Queries	5	0	0
Grants....	£751	0	0

General Statement of Sums which have been paid on Account of Grants for Scientific Purposes.

	£	s.	d.
1834.			
Tide Discussions	20	0	0
1835.			
Tide Discussions	62	0	0
British Fossil Ichthyology	105	0	0
	£167	0	0
1836.			
Tide Discussions	163	0	0
British Fossil Ichthyology	105	0	0
Thermometric Observations, &c.	50	0	0
Experiments on long-continued Heat	17	1	0
Rain Gauges	9	13	0
Refraction Experiments	15	0	0
Lunar Nutation	60	0	0
Thermometers	15	6	0
	£434	14	0
1837.			
Tide Discussions	284	1	0
Chemical Constants	24	13	6
Lunar Nutation	70	0	0
Observations on Waves	100	12	0
Tides at Bristol	150	0	0
Meteorology and Subterranean Temperature	89	5	3
Vitrification Experiments	150	0	0
Heart Experiments	8	4	6
Barometric Observations	30	0	0
Barometers	11	18	6
	£918	14	6
1838.			
Tide Discussions	29	0	0
British Fossil Fishes	100	0	0
Meteorological Observations and Anemometer (construction)	100	0	0
Cast Iron (strength of)	60	0	0
Animal and Vegetable Substances (preservation of)	19	1	10
Railway Constants	41	12	10
Bristol Tides	50	0	0
Growth of Plants	75	0	0
Mud in Rivers	3	6	6
Education Committee	50	0	0
Heart Experiments	5	3	0
Land and Sea Level	267	8	7
Subterranean Temperature	8	6	0
Steam-vessels	100	0	0
Meteorological Committee	31	9	5
Thermometers	16	4	0
	£956	12	2
1839.			
Fossil Ichthyology	110	0	0
Meteorological Observations at Plymouth	63	10	0
Mechanism of Waves	144	2	0
Bristol Tides	35	18	6
Meteorology and Subterranean Temperature	21	11	0
Vitrification Experiments	9	4	7
Cast Iron Experiments	100	0	0
Railway Constants	28	7	2
Land and Sea Level	274	1	4
Steam-vessels' Engines	100	0	0
Stars in Histoire Céleste	331	18	6
Stars in Lacaille	11	0	0
Stars in R.A.S. Catalogue	6	16	6
Animal Secretions	10	10	0
Steam-engines in Cornwall	50	0	0
Atmospheric Air	16	1	0
Cast and Wrought Iron	40	0	0
Heat on Organic Bodies	3	0	0
Gases on Solar Spectrum	22	0	0
Hourly Meteorological Observations, Inverness and Kingussie	49	7	8
Fossil Reptiles	118	2	9
Mining Statistics	50	0	0
	£1595	11	0
1840.			
Bristol Tides	100	0	0
Subterranean Temperature	13	13	6
Heart Experiments	18	19	0
Lungs Experiments	8	13	0
Tide Discussions	50	0	0
Land and Sea Level	6	11	1
Stars (Histoire Céleste)	242	10	0
Stars (Lacaille)	4	15	0
Stars (Catalogue)	264	0	0
Atmospheric Air	15	15	0
Water on Iron	10	0	0
Heat on Organic Bodies	7	0	0
Meteorological Observations	52	17	6
Foreign Scientific Memoirs	112	1	6
Working Population	100	0	0
School Statistics	50	0	0
Forms of Vessels	184	7	0
Chemical and Electrical Phænomena	40	0	0
Meteorological Observations at Plymouth	80	0	0
Magnetical Observations	185	13	9
	£1546	16	4

1841.

	£	s.	d.
Observations on Waves	30	0	0
Meteorology and Subterranean Temperature	8	8	0
Actinometers	10	0	0
Earthquake Shocks	17	7	0
Acrid Poisons	6	0	0
Veins and Absorbents	3	0	0
Mud in Rivers	5	0	0
Marine Zoology	15	12	8
Skeleton Maps	20	0	0
Mountain Barometers	6	18	6
Stars (Histoire Céleste)	185	0	0
Stars (Lacaille)	79	5	0
Stars (Nomenclature of)	17	19	6
Stars (Catalogue of)	40	0	0
Water on Iron	50	0	0
Meteorological Observations at Inverness	20	0	0
Meteorological Observations (reduction of)	25	0	0
Fossil Reptiles	50	0	0
Foreign Memoirs	62	0	0
Railway Sections	38	1	6
Forms of Vessels	193	12	0
Meteorological Observations at Plymouth	55	0	0
Magnetical Observations	61	18	8
Fishes of the Old Red Sandstone	100	0	0
Tides at Leith	50	0	0
Anemometer at Edinburgh	69	1	10
Tabulating Observations	9	6	3
Races of Men	5	0	0
Radiate Animals	2	0	0
	£1235	10	11

1842.

	£	s.	d.
Dynamometric Instruments	113	11	2
Anoplura Britanniæ	52	12	0
Tides at Bristol	59	8	0
Gases on Light	30	14	7
Chronometers	26	17	6
Marine Zoology	1	5	0
British Fossil Mammalia	100	0	0
Statistics of Education	20	0	0
Marine Steam-vessels' Engines	28	0	0
Stars (Histoire Céleste)	59	0	0
Stars (Brit. Assoc. Cat. of)	110	0	0
Railway Sections	161	10	0
British Belemnites	50	0	0
Fossil Reptiles (publication of Report)	210	0	0
Forms of Vessels	180	0	0
Galvanic Experiments on Rocks	5	8	6
Meteorological Experiments at Plymouth	68	0	0
Constant Indicator and Dynamometric Instruments	90	0	0
Force of Wind	10	0	0
Light on Growth of Seeds	8	0	0
Vital Statistics	50	0	0
Vegetative Power of Seeds	8	1	11
Questions on Human Race	7	9	0
	£1449	17	8

1843.

	£	s.	d.
Revision of the Nomenclature of Stars	2	0	0
Reduction of Stars, British Association Catalogue	25	0	0
Anomalous Tides, Frith of Forth	120	0	0
Hourly Meteorological Observations at Kingussie and Inverness	77	12	8
Meteorological Observations at Plymouth	55	0	0
Whewell's Meteorological Anemometer at Plymouth	10	0	0
Meteorological Observations, Osler's Anemometer at Plymouth	20	0	0
Reduction of Meteorological Observations	30	0	0
Meteorological Instruments and Gratuities	39	6	0
Construction of Anemometer at Inverness	56	12	2
Magnetic Co-operation	10	8	10
Meteorological Recorder for Kew Observatory	50	0	0
Action of Gases on Light	18	16	1
Establishment at Kew Observatory, Wages, Repairs, Furniture and Sundries	133	4	7
Experiments by Captive Balloons	81	8	0
Oxidation of the Rails of Railways	20	0	0
Publication of Report on Fossil Reptiles	40	0	0
Coloured Drawings of Railway Sections	147	18	3
Registration of Earthquake Shocks	30	0	0
Report on Zoological Nomenclature	10	0	0
Uncovering Lower Red Sandstone near Manchester	4	4	6
Vegetative Power of Seeds	5	3	8
Marine Testacea (Habits of)	10	0	0
Marine Zoology	10	0	0
Marine Zoology	2	14	11
Preparation of Report on British Fossil Mammalia	100	0	0

	£	s.	d.
Physiological operations of Medicinal Agents	20	0	0
Vital Statistics	36	5	8
Additional Experiments on the Forms of Vessels	70	0	0
Additional Experiments on the Forms of Vessels	100	0	0
Reduction of Observations on the Forms of Vessels ..	100	0	0
Morin's Instrument and Constant Indicator	69	14	10
Experiments on the Strength of Materials	60	0	0
	£1565	10	2

1844.

	£	s.	d.
Meteorological Observations at Kingussie and Inverness	12	0	0
Completing Observations at Plymouth	35	0	0
Magnetic and Meteorological Co-operation	25	8	4
Publication of the British Association Catalogue of Stars	35	0	0
Observations on Tides on the East coast of Scotland	100	0	0
Revision of the Nomenclature of Stars...........1842	2	9	6
Maintaining the Establishment in Kew Observatory	117	17	3
Instruments for Kew Observatory	56	7	3
Influence of Light on Plants	10	0	0
Subterraneous Temperature in Ireland	5	0	0
Coloured Drawings of Railway Sections	15	17	6
Investigation of Fossil Fishes of the Lower Tertiary Strata	100	0	0
Registering the Shocks of Earthquakes 1842	23	11	10
Structure of Fossil Shells ...	20	0	0
Radiata and Mollusca of the Ægean and Red Seas, 1842	100	0	0
Geographical distributions of Marine Zoology 1842	0	10	0
Marine Zoology of Devon and Cornwall	10	0	0
Marine Zoology of Corfu ..	10	0	0
Experiments on the Vitality of Seeds	9	0	3
Experiments on the Vitality of Seeds 1842	8	7	3
Exotic Anoplura...............	15	0	0
Strength of Materials	100	0	0
Completing Experiments on the Forms of Ships	100	0	0
Inquiries into Asphyxia......	10	0	0
Investigations on the internal Constitution of Metals	50	0	0
Constant Indicator and Morin's Instrument, 1842 ...	10	3	6
	£981	12	8

1845.

	£	s.	d.
Publication of the British Association Catalogue of Stars	351	14	6
Meteorological Observations at Inverness	30	18	11
Magnetic and Meteorological Co-operation	16	16	8
Meteorological Instruments at Edinburgh	18	11	9
Reduction of Anemometrical Observations at Plymouth	25	0	0
Electrical Experiments at Kew Observatory	43	17	8
Maintaining the Establishment in Kew Observatory	149	15	0
For Kreil's Barometrograph	25	0	0
Gases from Iron Furnaces...	50	0	0
The Actinograph	15	0	0
Microscopic Structure of Shells	20	0	0
Exotic Anoplura.........1843	10	0	0
Vitality of Seeds 1843	2	0	7
Vitality of Seeds 1844	7	0	0
Marine Zoology of Cornwall	10	0	0
Physiological Action of Medicines........................	20	0	0
Statistics of Sickness and Mortality in York	20	0	0
Earthquake Shocks ...1843	15	14	8
	£830	9	9

1846.

	£	s.	d.
British Association Catalogue of Stars.................1844	211	15	0
Fossil Fishes of the London Clay	100	0	0
Computation of the Gaussian Constants for 1839.........	50	0	0
Maintaining the Establishment at Kew Observatory	146	16	7
Strength of Materials.........	60	0	0
Researches in Asphyxia......	6	16	2
Examination of Fossil Shells	10	0	0
Vitality of Seeds.........1844	2	15	10
Vitality of Seeds.........1845	7	12	3
Marine Zoology of Cornwall	10	0	0
Marine Zoology of Britain...	10	0	0
Exotic Anoplura.........1844	25	0	0
Expenses attending Anemometers	11	7	6
Anemometers' Repairs.......	2	3	6

	£	s.	d.
Atmospheric Waves	3	3	3
Captive Balloons 1844	8	19	8
Varieties of the Human Race 1844	7	6	3
Statistics of Sickness and Mortality at York	12	0	0
	£685	16	0

1847.

	£	s.	d.
Computation of the Gaussian Constants for 1839...	50	0	0
Habits of Marine Animals...	10	0	0
Physiological Action of Medicines	20	0	0
Marine Zoology of Cornwall	10	0	0
Atmospheric Waves	6	9	3
Vitality of Seeds...............	4	7	7
Maintaining the Establishment at Kew Observatory	107	8	6
	£208	5	4

1848.

	£	s.	d.
Maintaining the Establishment at Kew Observatory	171	15	11
Atmospheric Waves	3	10	9
Vitality of Seeds...............	9	15	0
Completion of Catalogues of Stars	70	0	0
On Colouring Matters	5	0	0
On Growth of Plants.........	15	0	0
	£275	1	8

1849.

	£	s.	d.
Electrical Observations at Kew Observatory	50	0	0
Maintaining Establishment at ditto	76	2	5
Vitality of Seeds...............	5	8	1
On Growth of Plants.........	5	0	0
Registration of Periodical Phænomena	10	0	0
Bill on account of Anemometrical Observations......	13	9	0
	£159	19	6

1850.

	£	s.	d.
Maintaining the Establishment at Kew Observatory	255	18	0
Transit of Earthquake Waves	50	0	0
Periodical Phænomena	15	0	0
Meteorological Instrument, Azores	25	0	0
	£345	18	0

1851.

	£	s.	d.
Maintaining the Establishment at Kew Observatory (includes part of grant in 1849)	309	2	2
Theory of Heat	20	1	1
Periodical Phænomena of Animals and Plants	5	0	0
Vitality of Seeds	5	6	4
Influence of Solar Radiation	30	0	0
Ethnological Inquiries	12	0	0
Researches on Annelida	10	0	0
	£391	9	7

1852.

	£	s.	d.
Maintaining the Establishment at Kew Observatory (including balance of grant for 1850).....................	233	17	8
Experiments on the Conduction of Heat	5	2	9
Influence of Solar Radiations	20	0	0
Geological Map of Ireland...	15	0	0
Researches on the British Annelida	10	0	0
Vitality of Seeds..............	10	6	2
Strength of Boiler Plates ...	10	0	0
	£304	6	7

1853.

	£	s.	d.
Maintaining the Establishment at Kew Observatory	165	0	0
Experiments on the Influence of Solar Radiation	15	0	0
Researches on the British Annelida	10	0	0
Dredging on the East Coast of Scotland	10	0	0
Ethnological Queries	5	0	0
	£205	0	0

1854.

	£	s.	d.
Maintaining the Establishment at Kew Observatory (including balance of former Grant)..................	330	15	4
Investigations on Flax	11	0	0
Effects of Temperature on Wrought Iron	10	0	0
Registration of Periodical Phænomena	10	0	0
British Annelida...............	10	0	0
Vitality of Seeds...............	5	2	3
Conduction of Heat	4	2	0
	£380	19	7

Extracts from Resolutions of the General Committee.

Committees and individuals, to whom grants of money for scientific purposes have been entrusted, are required to present to each following meeting of the Association a Report of the progress which has been made; with a statement of the sums which have been expended, and the balance which remains disposable on each grant.

Grants of pecuniary aid for scientific purposes from the funds of the Association expire at the ensuing meeting, unless it shall appear by a Report that the Recommendations have been acted on, or a continuation of them be ordered by the General Committee.

In each Committee, the Member first named is the person entitled to call on the Treasurer, John Taylor, Esq., 6 Queen Street Place, Upper Thames Street, London, for such portion of the sum granted as may from time to time be required.

In grants of money to Committees, the Association does not contemplate the payment of personal expenses to the Members.

In all cases where additional grants of money are made for the continuation of Researches at the cost of the Association, the sum named shall be deemed to include, as a part of the amount, the specified balance which may remain unpaid on the former grant for the same object.

General Meetings.

On Wednesday, Sept. 20th, at 8 P.M., in the Philharmonic Hall, William Hopkins, Esq., M.A., F.R.S., F.G.S., resigned the office of President to the Earl of Harrowby, F.R.S., who took the Chair at the General Meeting, and delivered an Address, for which see page lv.

On Thursday, Sept. 21st, a Soirée took place in St. George's Hall, when experiments were exhibited with Ruhmkorff's Induction Coils, and Magnus's Polytrope.

On Friday, Sept. 22nd, at 8 P.M., in the Concert Room of St. George's Hall, Richard Owen, M.D., LL.D., F.R.S., Professor of Anatomy and Physiology in the Royal College of Surgeons of England, delivered a Discourse on Anthropomorphous Apes.

On Monday, Sept. 25th, at 8 P.M., in the Concert Room of St. George's Hall, Colonel Edward Sabine, R.A., V.P. and Treas. R.S., delivered a Discourse on the Progress of Researches in Terrestrial Magnetism.

On Tuesday, Sept. 26th, a Soirée took place in St. George's Hall, when Experiments with the Gyroscope were presented by M. Leon Foucault; Experiments with the electric Light, by the Abbé Moigno and M. Duboscq, were explained by Professor Stokes; and Photographs of the Moon were exhibited by the Photographic Society of Liverpool.

On Wednesday, Sept. 27th, at 3 P.M., the concluding General Meeting of the Association was held in St. George's Hall, Liverpool, when the Proceedings of the General Committee, and the Grants of Money for scientific purposes, were explained to the Members.

The Meeting was then adjourned to Glasgow *.

* The Meeting is appointed to take place on Wednesday, the 12th of September, 1855.

ADDRESS

BY

THE EARL OF HARROWBY, F.R.S.

Gentlemen of the British Association,

When I first set myself to the task of preparing to address you on the present occasion, my impulse was to begin with an apology for appearing before you in so prominent a position—for assuming apparently a station in the world of science for which I had no pretensions. On second thoughts, however, it appeared better—more respectful in fact, having consented, though with unfeigned reluctance, to accept the office—to say no more on that head, but to discharge its duties as best I might. This, however, I must ask of you, not to expect from me what you have had from many of my predecessors, a luminous review of the state of Physical Science—a recital of its recent various triumphs, and suggestions for their further extension: that I should, in the words of the poet, though in a different sense,

> Allure to brighter worlds, and point the way.

Though I have been no indifferent spectator of that rapid and triumphant march of science, which, within the last fifty years, has been extending and enriching the old domains of knowledge, and planting, as it were, new colonies in hitherto unexplored and untrodden regions, yet I have been only a spectator,—my avocations have been less with the properties of matter than with the busy concerns of men; and if I attempted now to assume for the first time the philosophic garb, I am afraid that the awkwardness of my gait would soon betray me. There are, however, some points of high and general interest, which, in a meeting like the present, cannot be entirely neglected, and in regard to which the kindness of friends has supplied me with some matter not unworthy of being submitted to your notice. How, for instance, in the land of Newton, and in the greatest seaport of the world, should I neglect Astronomy? And here Prof. Challis has been good enough to furnish me with a statement of its present condition and recent progress, which, with your permission, I will lay before you:—

"*Notes on the present State of Astronomy.*

"Memorandum by Prof. Challis.

"Since the Meeting of the British Association last year, four planets and four comets have been discovered. Three of the new planets were found at Mr. Bishop's Observatory, two by Mr. Hind, and one by Mr. Maith. This last was also discovered the following night at the Oxford Observatory—another of the many instances presented by astronomy of independent discoveries made nearly simultaneously. The fourth planet was found at the Observatory of Bilk, near Düsseldorf, by Mr. R. Luther, an astronomer distinguished by having already discovered two planets. Of the comets, one was discovered at Berlin, two at Göttingen, and the fourth was seen very generally with the naked eye at the end of last March. None of them have been identified with preceding comets. The large number of planets and comets discovered of late years, while it evinces the diligence of astronomers, has, at the same time, brought additional labourers into the field of astronomical science, and contributed materially to its extension. The demand for observations created by these discoveries has been met by renewed activity in existing observatories, and has led to the establishment, by public or private means, of new observatories. For instance, an observatory was founded in the course of last year by a private individual at Olmütz, in Moravia, and is now actively at work on this class of observations. Various such instances have occurred within a few years. In addition to the advantages just stated, the observations called for by the discovery of new bodies of the Solar System, have drawn attention to the state of Stellar Astronomy, and been the means of improving this fundamental part of the science. The following are a few words on the existing state of Stellar Astronomy, so far as regards catalogues of stars. Subsequently to the formation of the older catalogues of bright stars, astronomers turned their attention to observations in zones, or otherwise of smaller stars, to the ninth magnitude inclusive. Lalande, Lacaille, Bessel, Argelander, and Lamont are the chief labourers in this class of observations. But these observations, unreduced and uncatalogued, are comparatively of little value. The British Association did great service to astronomers by reducing into catalogues the observations of Lalande and Lacaille. A catalogue of part of Bessel's Zones has been published at St. Petersburg, and a catalogue of part of Argelander's Zones at Vienna. Lamont's Zones have also been reduced in part by himself. The catalogue of 8377 stars, published by the British Association in 1845, is founded mainly on the older catalogues, but contains also stars to the seventh magnitude inclusive, observed once only by Lalande or Lacaille. The places of the stars in this catalogue are, consequently, not uniformly trustworthy; but as the authorities for the places are indicated, the astronomer is not misled by this circumstance. The above are the catalogues which are principally used in the observations of the small planets and of comets. This class of observations must generally be made by means of stars as fixed points of reference. The observer selects a star from a catalogue, either for the purpose of finding the moving body, or for comparing its position with that of the star; but from the imperfection of the catalogue, it sometimes happens that no star is found in the place indicated by it, and in most cases, unless the star's place has been determined by repeated meridian observations, it is not sufficiently accurate for final reference of the position of the planet or comet. In catalogues reduced from zone observations the star's right ascension generally depends on a single transit across a single wire, and its declination on a single bisection. This being the case, astronomers have begun to feel the necessity of using the catalogue places of stars provisionally in reducing their observations, and of obtaining afterwards accurate places by meridian observations. It will be seen by this statement, that by the observations of the small planets and of comets, materials are gradually accumulating for the formation of a more accurate and more extensive catalogue of stars than any hitherto published. The British Association would add greatly to the benefits it has already conferred on astronomical science, by promoting the publication, when sufficient materials can be collected, of a *general catalogue of all stars to the ninth magnitude inclusive, which have been repeatedly observed with meridian instruments.* The modern sources at present available for such a work are the reduced and published observations of the Greenwich, Pulkowa, Edinburgh, Oxford and Cambridge observatories, and the recently completed catalogue of 12,000 stars observed and reduced by the indefatigable astronomer of Hamburg, Mr. Charles Rümker, together with numerous incidental determinations of the places of comparison stars in the *Astronomische Nachrichten*. To complete the present account of the state of Stellar Astronomy, mention should be made of two volumes recently published by Mr. Cooper, containing the approximate places arranged in order of right ascension of 30,186 elliptic stars from the ninth to the twelfth magnitude, of which only a very small number had been previously observed. The observations were made with the Markree Equatorial, and have been printed at the expense of Her Majesty's Government. The determination of differences of longitude by galvanic signals is an astronomical matter of great practical importance. This method, employed first in America, was introduced into England by the Astronomer Royal, and has been applied to the determination in succession of the differences of longitude between the Greenwich Observatory and the observatories of Cambridge, Edinburgh, Brussels, and Paris. In the first and last instances results have been published which prove the perfect success and accuracy of the method. Mr. Airy, on recently announcing in the public papers the completion of the operation between the Greenwich and Paris observatories, justly remarks that such an experiment could not have been made without the assistance afforded by commercial enterprise, and that commercial enterprise is in turn honoured by the aid thus rendered to science. In the summer of last year, Prof. Encke, following the example set in England, determined successfully by galvanic signals the difference of longitude between Berlin and Frankfort-on-the-Maine. Galvanism has also been applied to astronomical purposes in other ways. The method of observing transits by the intervention of a galvanic circuit (just put in practice in America), in which only sight and touch are employed, and counting is not required, is now in operation at the Greenwich Observatory. It is found to be attended with more labour than the old method; but as it is free from errors to which the other method is liable, it lays claim to general acceptance. At Greenwich, also, the galvanic circuit is most usefully employed in maintaining the movements of distant sympathetic clocks, and in dropping time signal balls. A ball is dropped every day at Deal by a galvanic current from the Royal Observatory. Some anxiety was felt by astronomers respecting the continuation of that most indispensable publication the *Astronomische Nachrichten*, after the decease of the editor, M. Petersen, in February last. This has been dispelled by a recent announcement that the King of Denmark has resolved to maintain the Altona Observatory in connexion with that of the editorship of that work. The 'Astronomical Journal,' an American publication of the same kind, undertaken by a young astronomer and mathematician, Mr. Gould, for the especial information of his countrymen, has reached the end of Volume III., and will, it is hoped, be continued. Generally, it may be said of astronomy, at the present time, that it is prosecuted zealously and extensively, active observations being now more numerous than ever, and that the interests of the science are promoted as well by private enterprise as by the aid of Governments.

"Cambridge Observatory, Sept. 14, 1854." "J. CHALLIS."

You will have observed that Prof. Challis speaks of the activity of private enterprise in the cause of astronomy, and can I in this place pass over the labours of a Lassells, or the enlightened public spirit of the corporation of this town, which, stimulated by your visit in the year 1837, has now for some years maintained an excellent and well-provided observatory, under the able management of Mr. Hartnup, who has not only conferred great benefits on the navigation of the place by the regulation of its chronometers, but great honour upon the institution by the general services which he has rendered to meteorological, as well as astronomical science? Mr. Hartnup's improvements in the chronometer, by which the errors arising from variations of temperature are either corrected or estimated and allowed for, have been of the greatest value. In the words of a Report of the Council of the Royal Astronomical Society, "It is found experimentally, that when a captain will apply the rate thus corrected for temperature, the performance of chronometers is much improved;" and in regard to the importance of the subject to the practical interests of navigation, I would take the liberty of quoting further:—"There are risks at sea, against which no foresight can provide; but loss from defective compasses or ill-regulated chronometers should be treated as a crime; since common sense and common care will secure the efficacy of both these instruments. It is to be feared that life and property to a large amount are yearly sacrificed for a want of a little elementary knowledge, and a small amount of precaution on the part of our seamen, who neglect the safeguards furnished by modern science."

You may remember, that at the period of your last Meeting, arrangements with Government were in progress for the construction of a reflecting telescope of four-feet aperture, which should bring to bear upon the nebulæ and other starry phænomena of the southern hemisphere a far higher power than that to which they had been submitted by Sir John Herschel. You will regret to hear that, although the estimate was not objected to by the Government, it has not yet been submitted to Parliament. We must make some allowance for the pre-occupations of war.

The labours of your Kew Committee are carried on with unabated assiduity and extending usefulness. You will, perhaps, forgive me for taking the liberty of urging upon you the importance of continuing to them an unabated if not an enlarged support. By giving accuracy to the various implements of observation,—the thermometer, the barometer, and the standard weights and measures,—they are doing a work of incalculable benefit to science in general, in this and in other countries. At this moment they have in their hands for verification and adjustment, 1000 thermometers and 50 barometers for the navy of the United States, as well as 500 thermometers and 60 barometers for our own Board of Trade, the instruments which are supplied in ordinary commerce being found to be subject to error to an extraordinary degree. At the suggestion of Sir John Herschel, they have also undertaken, by the photographic process, to secure a daily record of the appearance of the sun's disc, with a view of ascertaining, by a comparison of the spots upon its surface, their places, size, and forms, whether any relation can be established between their variations and other phænomena. The Council of the Royal Society has supplied the funds, and the instrument is in course of completion. The same beautiful invention, which seems likely to promote the interests of science in many branches, at least as much as those of art, is employed, under the able direction of the Committee, and of Mr. Welsh, the Curator, to record, by a sélf-acting process, something similar to that of the anemometer, the variations in the earth's magnetism. But I will not pretend to anticipate the results of the careful and extended study of this subject by our able associate, Col. Sabine, who has been kind enough to promise that we shall hear them from his own mouth in one of our evening meetings. Neither will I anticipate the report of my learned and distinguished predecessor in this chair, Mr. Hopkins, on a subject to which he called the attention of the Association at its last meeting, and on which, in conjunction with Mr. Fairbairn and Mr. Joule, he has been engaged in a series of experiments :—I allude to the effects of pressure on the temperature of fusion,—a problem of great importance, as bearing on the internal condition of our planet.

A Report of a Committee of the Institute of France, consisting of MM. Lionville, Lamé and Élie de Beaumont, on the subject of a Theory of Earthquakes, has been transmitted to me for the use of the Association. From a careful discussion of several thousand of these phænomena, which have been recorded between the years 1801 and 1850, and a comparison of the periods at which they occurred with the position of the moon in relation to the earth, the learned Professor, M. Perrey of Dijon, would infer that earthquakes may possibly be the result of an action of attraction exercised by that body on the supposed fluid centre of our globe, somewhat similar to that which she exercises on the waters of the ocean; and the Report of the Committee of the Institute is so far favourable, that at their instance the Institute have granted funds to enable the learned Professor to continue his researches. You will recollect how often the attention of the Association has been drawn to this subject by the observations of Mr. Milne and of Mr. Mallet, which latter are still going on; and that the accumulating facts are still waiting for a theory to explain them.

On Geology.—I am sorry for the slightness of my acquaintance with so captivating as well as so practical a study. I have nothing to report, save that the increasing scarcity of ironstone and coal is driving the practical men to have greater respect for a science which enables them to form a very sound conjecture where such minerals are likely to be found, and to come to something like an absolute certainty as to where they are not. When the questions begin to be asked, "Is there a square mile in all the coal-fields of Britain unoccupied by the mines?"—"Of its 5000 square miles of visible coal tract how much remains untouched?"—it is time, indeed, to listen to that science which has taught us so successfully, in the hands of a Murchison, a Phillips, and others, where further resources for the supply of this, the life of Britain, is to be found.

I need hardly tell you of the services which Meteorology may be expected to render to practical life, and perhaps there is no better instance of the value of the accumulation of facts, though in themselves apparently of small importance, and having apparently little connexion with each other.

What apparently can be less subject to rule and law, even to a proverb, than the changeful wind, and the treacherous wave? Yet, even here, observation and comparison have done some good work for science and for man, and are about to do more. You are all aware that the American Government have now for some years, at the instance and under the direction of Lieut. Maury, been collecting from the mercantile vessels of that nation observations of certain phænomena at sea, such as winds, tides, currents and temperature of the ocean; and that the results, digested into charts and books, have already been the means of adding speed and safety to the voyages of their merchantmen in an extraordinary degree.

You are aware that application was made to our Government to cooperate in this great work of common benefit to every mercantile nation, and that the subject was brought before Parliament by one of our Vice-Presidents, Lord Wrottesley, in a speech which he has since published, and which I would commend to every one's perusal who doubts of the importance of this branch of science to the interests of commerce and navigation. You are perhaps not aware that the Government has agreed to the proposal, and has created a special department for the purpose, in connexion with the Board of Trade, placing it under the management of perhaps the one man best fitted to carry it out with energy and success, my friend Capt. FitzRoy, one not less known on the banks of the Mersey by old associations, than on the general fields of maritime science. Conceiving that this was a subject of special interest to the place of our present Meeting, and that for such an object it was desirable as publicly and as widely as possible to solicit the cooperation of all who are connected with the commerce of the country, I have asked Capt. FitzRoy to communicate to me the present condition of the question; and he has kindly furnished me, not officially, with the following memoranda, which, with your permission, I will read:—

"*Memorandum* I.—The maritime commerce of nations having spread over the world to an unprecedented extent, and competition having arrived at such a point that the value of cargoes and the profits of enterprise depend more than ever on the length and nature of voyages, it has become a question of the greatest importance to determine the best tracks for ships to follow, in order to make the quickest as well as the safest passages. The employment of steamers in such numbers, the general endeavour to keep as near the *direct* line between two places (the arc of a great circle) as the intervening land, currents and winds will allow, and the improvements in navigation, now so prevalent, have caused a demand for more precise and readily available information respecting all frequented parts of the Ocean. Not only is greater accuracy of detail required, but much more concentration and arrangement of very valuable, though now scattered, information. Besides which, instrumental errors have vitiated too many results, and have prevented the greater portion of the meteorological observations hitherto made at sea from being considered better than approximations. 'It is one of the chief points of a seaman's duty,' said the well-known Basil Hall, 'to know where to find a fair wind, and where to fall in with a favourable current:' but, with the means at present accessible, the knowledge of such matters can only be acquired by years of toil and actual experience, excepting only in the greater thoroughfares of the oceans, which are well known. Wind and Current Charts have been published of late years, chiefly based on the great work of the United States Government, at the suggestion of, and superintended by Lieut. Maury; and by studying such charts and directions, navigators have been enabled to shorten their passages materially; in many cases as much as one-fourth, in some one-third, of the distance or time previously employed. Much had been collected and written about the winds and currents by Rennell, Capper, Reid, Redfield, Thom, Piddington, and others; but general attention was not attracted to the subject, however important to a maritime country, till the publication of Lieut. Maury's admirable observations. Encouraged by the practical results obtained, and induced by the just arguments of that officer, the principal maritime powers sent duly qualified persons to assist at a conference held at Brussels last year on the subject of meteorology at sea. The report of that conference was laid before

Parliament, and the first direct result of it was a vote of money for the purchase of instruments and the discussion of observations. All the valuable meteorological data which have been collected at the Admiralty, and all that can be obtained elsewhere, will be tabulated and discussed in this new department of the Board of Trade, in addition to the continually accruing and more exact data to be furnished in future. A very large number of ships, chiefly American, are now engaged in observations; stimulated by the advice, and aided by the documents so liberally furnished by the United States Government, at the instance of Lieut. Maury, whose labours have been incessant. Not only does that Government offer directions and charts gratis to American ships, but also to those of our nation, in accordance with certain easy and just conditions. In this country, the Government, through the Board of Trade, will supply a certain number of ships which are going on distant voyages with 'abstract logs' (or meteorological registers) and instruments gratis, in order to assist effectively in carrying out this important national undertaking. In the preface to a late edition of Johnston's 'Wind and Current Charts,' published last June at Edinburgh, Dr. Buist says,—'It has been shown that Lieut. Maury's charts and sailing directions have shortened the voyages of American ships by about *a third*. If the voyages of those to and from India were shortened by no more than *a tenth*, it would secure a saving, in freightage alone, of £250,000 annually. Estimating the freights of vessels trading from Europe with distant ports at £20,000,000 a year, a saving of a tenth would be about £2,000,000; and every day that is lost in bringing the arrangements for the accomplishment of this into operation occasions a sacrifice to the shipping interest of about £6000, without taking any account of the war navies of the world.' It is obvious that, by making a passage in less time, there is not only a saving of expense to the merchant, the shipowner, and the insurer, but a great diminution of the risk from fatal maladies,—as instead of losing time, if not lives, in unhealthy localities, heavy rains, or calms with oppressive heat, a ship properly navigated may be speeding on her way under favourable circumstances. There is no reason of any insuperable nature why every part of the sea should not be known as well as the land, if not indeed better than the land generally speaking, because more accessible and less varied in character. Changes in the atmosphere, over the ocean as well as on the land, are so intimately connected with electrical agency (of course including magnetism), that all seamen are interested in such matters, and the facts which they register become valuable to philosophers. Meteorological information collected at the Board of Trade will be discussed with the twofold object in view—of aiding navigators, or making navigation easier, as well as more certain,—and amassing a collection of accurate and well-digested observations for the future use of men of science.

"*Memorandum* II.—As soon as the estimate for meteorological expenses had passed, steps were taken to organize a new branch department at the Board of Trade. On the 1st of August, Capt. FitzRoy was appointed to execute the duties of this new office, referring to Dr. Lyon Playfair, of the Department of Science and Art, and to Admiral Beechey, of the Marine Department, for such assistance as they could render. As soon as registers and instruments are ready, and an office prepared, Capt. FitzRoy will be assisted by four or five persons, whose duties he will superintend. It is expected that several ships will be supplied with 'abstract logs' (meteorological registers) and instruments in October, and that the office will be in full work next November. The Admiralty have ordered all the records in the Hydrographical Office to be placed at the disposal of the Board of Trade for a sufficient time. All other documents to which Government has access will be similarly available; and the archives of the India House may likewise be searched. There will be no want of materials, though not such as would have been obtained by using better instruments on a systematic plan. Capt. FitzRoy ventures to think that the documents hitherto published by Lieut. Maury present too much detail to the seaman's eye; that they have not been adequately condensed; and therefore are not, practically, so useful as is generally supposed. His Instructions or Sailing Directions (the real condensed results of his elaborate and indefatigable researches) have effected the actual benefits obtained by mariners. Reflecting on this evil, which increasing information would not tend to diminish, Capt. FitzRoy proposes to collect all data, reduced and meaned (or averaged) in a NUMBER of conveniently arranged tabular books, from which, at a subsequent period, diagrams, charts, and 'meteorological dictionaries,' or records, will be compiled, so that, by turning to the latitude and longitude, all information about that locality may be obtained at once, and distinctly."

I cannot doubt that the spirited merchants and shipowners of England will not be slow to follow the example of their brethren in the United States, and will lend their heartiest assistance to a work so useful. Great facilities will be afforded them in the way of instruments of tested accuracy; and the increasing number of scientific seamen which is resulting from the local institutions of education; and the system of examination of masters and mates for certificates, will furnish them with observers in every part of the ocean, fit to be entrusted with such instruments and skilful in their use. Let not the practical man think lightly of such matters when he is reminded of the great services of the barometer in forewarning of the coming storm, and that the ascertained temperature of the sea, which his ship is traversing, will inform her master whether he is engaged in one current or another, and announce to him the approach of the dangerous iceberg when it is not discoverable by any other means.

I will now, with your permission, proceed to the consideration of some other departments of our work, such as Geography, Ethnography and Statistics, which are more connected with my own pursuits, which, affected as they are by the character of man, the uncertainties of his will, and the accidents of his physical and moral nature, and thus being less the subjects of direct and pure experiment, seem at first sight to be hardly reducible to those fixed laws, which it is the object of science to investigate and ascertain. For these reasons, indeed, among others, these branches of study formed at first no part of the scheme of the British Association, and there was some doubt about their subsequent admission.

Nevertheless, I rejoice that they were so admitted. The apprehension that they must introduce the spirit of party into our proceedings has been most honourably disappointed; and as one who, in the capacity of a member of the legislature, have to act from time to time on the subject of some of their inquiries, I cannot but express my gratitude for the assistance which they have afforded, both by informing and forming the public mind on many important questions; and, above all, for the lesson they have taught on the importance of testing every theory by a patient collection and impartial discussion of the facts; in a word, for having imported the spirit of science into what, in the largest sense of the word, may be called politics, instead of importing the spirit of politics, in its narrower sense, into science.

What is more important than to rescue questions of this nature, such as Finance and Political Economy, for instance, in some degree at least, from the domain of party contention? And how can we better contribute to that desirable result, than by discussing the carefully collected facts in a scientific spirit, on an arena within which no party passion is excited, no party allegiance is acknowledged, no party victory has to be lost or won, and when men are at liberty to convince and be convinced without risking a charge of treachery or a change of ministry as the consequence? But, in fact, these studies could not fairly have been excluded from our peripatetic university of science. Who shall separate Political altogether from the influences of Physical Geography, or Ethnology from Physiology, or the destinies of man upon this globe from the study of his physical nature? By its employment of the doctrine of probabilities, one branch of statistics is brought into immediate contact with the higher mathematics, and the actuary is thus enabled to extract certainty in the gross out of uncertainty in the detail, and to provide man with the means of securing himself against some of the worst contingencies to which his life and property are exposed. In fact, statistics themselves are the introduction of the principle of induction into the investigation of the affairs of human life;—an operation which requires the exercise of at least the same philosophical qualities as other sciences. It is not enough in any case merely to collect facts and reduce them into a tabular form. They must be analysed as well as compared; the accompanying circumstances must be studied (which is more difficult in moral than in material investigations), that we may be sure that we are calling the same things by the same names; *i. e.* in reality treating of the same facts under the same circumstances; and all disturbing influences must be carefully eliminated before any such pure experiment can be got at as can fairly be considered to have established a satisfactory conclusion. In some cases this is easier than in others. In regard to the probabilities of life or health, for instance, there are, at least, no passions or prejudices, no private interests at work to interfere with the faithful accumulation of the facts, and if they be numerous enough, it might be supposed that their number would be a sufficient protection against the effect of any partial disturbances. But even here, caution and special, as well as extensive, knowledge are required. There are disturbing influences even here,—habits of life, nature of employment, immigration or emigration, ignorance or misstatement of age, local epidemics, &c., which leave sources of error in even the most extended investigations. Still results are attained, errors are more and more carefully watched against and allowed for or excluded, and more and more of certainty is gradually introduced. And here I should not omit to notice the valuable services of the Society of Actuaries not long ago established, and who are represented in our Statistical Section. They discuss all questions to which the science of probability can be applied, and that circle is constantly extending:—assurance in all its branches, annuities, reversionary interests, the laws of population, mortality, and sickness; they publish 'Transactions,' and what is of the greatest importance in this, as indeed in any branch of inductive science, they hold an extensive correspondence with foreign countries. In fact, they are doing for the contingencies of human life, and for materials apparently as uncertain, something like what meteorology is doing for the winds and waves.

What shall I say to the statistics of crime, of education, of pauperism, of charity, at once and reciprocally the effect and the cause of that increasing attention to the condition of the people, which so favourably distinguishes the present age? Who can look at the mere surface of society, transparently betraying the abysses which yawn beneath, and not desire to know something of their secrets, to throw in the moral drag, and to bring to the light of day some of the phænomena, the monstrous forms of misery and vice which it holds within its dark recesses?—and who can look at these things, no longer matter of conjecture, but ascertained, classed, and tabled, without having the desire awakened or strengthened to do something towards remedying the evils thus revealed, and without feeling himself guided and assisted towards a remedy? Yet here, more than in other cases, should a man suspect himself; here should he guard himself against hasty conclusions, drawn from the first appearance of the results; for here are disturbing influences most busily at work, not only from without, but from within,—not only in the nature of the facts themselves, but in the feelings, passions, prejudices, habits, and moral constitution of the observer.

Still the tabling of the facts is of infinite importance. If they disturb, as they are sure to do, some feeling, some prejudice, some theory, some conviction, it will be felt, that any how the facts have to be accounted for; further investigation will follow; and if it appear that no correction is required, the truth will be established, and the hostile theory will, sooner or later, give way and disappear. In these things, it is, of course, more than usually important that the facts to be selected for collection should be such as are, in their own nature and under the circumstances, likely to be ascertained correctly, and that the business of collection should be in the hands of those who have no bias to do it otherwise than fairly, no interest in the result: and this was, I believe, kept studiously in view by those who had the management of our great statistical work, the recent Census of our own country, which we are still studying; but, whether they were successful or not, in this respect, has already become matter of discussion.

The work itself is, undoubtedly, one of the greatest monuments that has ever been presented to a nation, as a record of its own constituent elements and conditon; compiled and commented on with singular industry, judgement, acuteness, and impartiality,—the Doomsday-book of the *people* of England, as the great volume of the Conqueror was of its *surface*.

Nor can I, while speaking of statistics, avoid referring to the Statistical Congress which took place at Brussels about this time last year; which had mainly for its object to produce uniformity among different nations in the selection of the facts which they should record, and in the manner of recording them; without which, indeed, no satisfactory comparisons can be established, no results can safely be deduced. To bring about such a uniformity absolutely is, I am afraid, hopeless; inasmuch as the grounds of difference are, in many cases, so deeply imbedded in the laws, the institutions, and the habits of the different countries, that no hammer of the statist is likely to remove them.

To understand, however, the points of difference, even if they are not removed, is in itself one great step towards the object. It at least prevents false conclusions, if it does not fully provide the means of establishing the true ones. It gets rid of sources of error, even if it fail of giving the full means of ascertaining truth. Take, for instance, the case of criminal statistics. We wish to ascertain the comparative prevalence of different crimes, either at different times or in different countries. For this purpose must we not know under what heads the jurists and statists of the times or countries to be compared array the various offences which are recorded; with what amounts of penalty they were visited; and with what rigour, from time to time, the penalties were enforced?

That which is called manslaughter in one country, and assassination in another, is called murder in a third. That which in one country is punished with death, in another is visited by imprisonment. The bankruptcy which in one country is a crime, in another is a civil offence. The juvenile offences which in one country are punished by imprisonment, and swell the criminal calendar, in another are treated, as they should in many cases be, only as a subject of compassion and correction,—take no place in the criminal calendar at all.

Indeed, it is one of the difficulties which beset a large proportion of these investigations, whether into morals, health, education, or legislation, and which must always distinguish them from those which deal either with matter or defined abstractions, that, as I have said before in using the same terms, we are often uncertain whether we mean the same thing; whether, in fact, when we are using the same denominations, the same weights and measures are really employed. Such conferences, however, as those of Brussels tend much to limit the extent of error.

Among the objects which may best occupy the attention of the Statistical Section at the present moment, will be the discussion of a decimal coinage, and the statistics of agricultural produce. It is important in regard to both, that by previous sifting and discussion not only the best conclusions should be arrived at, but the subject should be so familiarized to general apprehension as to secure the widest co-operation. In regard to a change in the coinage, the interests and feelings of the lower classes must be especially consulted; and, with this view, without expressing any ultimate opinion, I would recommend to those who are considering the question, the perusal of a pamphlet, full of important matter, by the late Mr. Laurie, the work of the last hours of a man of eminent knowledge and virtue, which he had hoped to be able to communicate in person, as a paper, to the present Meeting. With regard to the statistics of agriculture, if the object be to procure such a knowledge of the facts as shall guide the operations of the consumer and the merchant, I would suggest that they should be taken and published at two periods of the year, once in the spring, recording the extent of soil devoted to each kind of grain,—a fact easily ascertained; the second time as soon as the harvest is concluded,—announcing the amount of the crop, as ascertained on several specimen fields under different circumstances of soil and climate, and applied in due proportion as a multiple to the acreage already published. A really accurate census of the harvest is, I believe, impracticable, at least within the period which would alone make it valuable for present use; and the approximation which I have suggested would, I conceive, be adequate to the purpose.

In regard to Geography and Ethnography, there are few Sections, I believe, which have more general interest, and none, I imagine, which would be more attractive here,—where every new discovery is connected with the immediate interests of the place, a new source of raw material, or a new destination for finished work; and where every new communication, established and reported, is another channel for the extension of that commerce, which, bursting from the channels of the Mersey, permeates and percolates every creek and cranny of the known world.

The great navigations which are opening up the heart of the South American continent, by the Paraguay, the Amazons, and the Orinoco; that are traversing and uniting the colonies of Victoria and South Australia by the river Murray; the projected exploration of North Australia, which, I am sorry to say, is as yet only a project, and may require some of the fostering warmth of the Association to bring it into actual existence; the wonderful discoveries in South Africa by Livingston and Anderson,—and the explorations of Central Africa by Barth and Vogel; the pictures given us by Capt. Erskine and others of the condition of the islanders of the South Pacific, passing by every stage of transition from the lowest barbarism to a fitness for the highest European and Christian culture; these, and a hundred other topics, awaken an ever-new interest in the mind of the philosopher and statesman, in the feelings of the Christian and the lover of his kind. What new fields for science! What new opportunities for wealth and power! What new openings for good! How important that those who issue from this great emporium of modern commerce—this more than Tyre of modern times—should know how to turn them to advantage! Surely your periodical visits here, with their kindling, stimulating—I was going to say contagious—influences, are no mean instrument for such a purpose.

It cannot be for nothing that the heroes of every branch of science are assembled from many countries within these walls, and are brought into personal contact with the most enterprising and public-spirited of our merchants; that, in the language of my distinguished predecessor in this chair, slightly adapted, "the counting-house is thus brought into juxtaposition with the laboratory and the study." Commerce will more than ever be auxiliary to science, and science more than ever the helpmate of commerce; and a still further impulse will be given to those beneficial influences, which, in spite of some painful, though necessary interruption, occasioned by our present state of war, a good Providence is so visibly extending over the whole habitable globe.

It is happily becoming every year less and less necessary to press these things on public notice. In an age of gas and steam—of steam-engines and steam-boats—of railroads, and telegraphs, and photographs—the importance of science is no longer questioned. It is a truism—a commonplace. We are far from the foundation days of the Royal Society, when, in spite of the example of the monarch, their proceedings were the ridicule of the Court; and even the immortal Butler thought the labours of a Wallis, a Sydenham, a Harvey, a Hooke, or a Newton, fit subjects for his wit.

It is still, however, worth inquiring whether sufficient facilities for education in science exist or are in progress in our country; and whether Government or other important bodies provide sufficient encouragement and reward for its prosecution.

Now, in regard to the former, there can be no doubt that, until a very late period, the assistances to scientific education furnished in this country either by educational institutions or the State were very slight, and totally unworthy of the object or the nation. Look at the lower schools: until very lately nothing but reading and writing, and hardly that, was ever offered to the labouring classes. Look at the grammar schools: they were limited to the acquisition of a small modicum of Greek and Latin, often not even of arithmetic. The middle classes of society, those who did not send their children to the Universities, had no opportunity of acquiring any, the slightest, knowledge of science, whether practical or abstract, save from the untested, ill-respected teachers at private commercial schools, or from the casual visit of an itinerant lecturer with his travelling apparatus. But what did the Universities? My own university, Oxford, to which I acknowledge in other respects the highest obligations, did little for physical science. True, that the study of Mathematics, as an exercise and training of the understanding, received its honours there, though the genius of the place has never yet been favourable to the pursuit. True, that until comparatively a recent period, the honours of the sister University were exclusively, or nearly so, confined to the same science; and that the school of Newton has seldom been without names not unworthy of such a founder. But even there the Mathematics were still too exclusively regarded as a mere training of the understanding, and not as an instrument for the discovery of further truth; and the fair tree of science, planted within the academic courts, though healthy and vigorous, was somewhat barren of fresh fruit. Such as it had been in the time of Newton, such, in a great degree, for a century and a half, at least, it remained. But to other than mathematical science, I believe I may say at either University, encouragement there was little or none. If now and then a professor was to be found whose title promised something of the kind, on approaching him you would find that his existence was little more than nominal; that his courses were not frequented, even if they were offered,—or if at all, only by those who were considered rather as the idle men; because success in them was not only no advantage in the University career, but, by the time which they abstracted from the rewarded studies, was a positive loss and obstruction in the way of the honours and emoluments of the place. So that it might fairly be said, that if any advance was made in such sciences, at least in the Universities of England, it was rather in spite of, than by reason of, the system pursued in those otherwise useful, noble and magnificent institutions. In Scotland, indeed, the extended study of medicine, connected as it is with so many other branches of science, together with the less amount of artificial forcing into other studies, led naturally to the pursuit of physical science, and a Black and a Gregory, a Leslie and a Playfair had no rival contemporary names at Oxford and Cambridge. The names of a Whewell and a Herschel, an Airy, a Challis, and a Sedgwick, of a Powell and a Daubeny, and a Buckland,—alas, that he is only a name now!—would forbid the assertion in regard to more recent times. But what, meanwhile, was the State doing? That State which, with its limited population and territory, depends not upon the number of its people, but upon the individual value of each man,—not upon the number of its acres, but upon their skilful cultivation,—not even upon the resources of its surface, however well developed, but upon the mines which lurk beneath it,—not even upon its mines, but upon all the various and varying manufactures which these mines give extraordinary facilities for carrying on; not even on these manufactures, but on the extended commerce and navigation, which are necessary to provide the materials to draw them forth from the remotest corners of the earth, and to send them back with speed, safety, and œconomy, in another form and combination, often to the very spots from which they were derived;—in a word, dependent for the full development of its agriculture, its mining industry, its manufactures and its commerce, upon the widest extension and the fullest cultivation of Chemistry, of Natural History, of Mineralogy, of Geology, of Astronomy, of Meteorology and Mechanics. What did the State for these things? Why, absolutely nothing. There was for a time a Board of Longitude, which, instead of enlarging and improving it, it abolished; a Board of Agriculture, which it dropped; a School of Naval Architecture, which, at the bidding of a narrow œconomy, and at the instance of so-called practical men, it abolished when the fruits were ripening; a School of Naval Instruction at Portsmouth, which it dropped. Here and there still survives a grant from the bounty of an individual monarch, grudgingly adopted by the State,—of 10*l.* for a Professor of Natural Philosophy at Aberdeen, or 50 guineas for a similar Professor at St. Andrew's, or 150*l.* to one at Glasgow, or 30*l.* to one at Edinburgh, and, more recently, grants of 100*l.* a year each to four or five Professors, in each of the old Universities of England. This is, as far as I can discover, all that the magnificent State of Britain did, until recently, for that Science on which her wealth,—and if her wealth, her power,—and if her power, her very existence,—is dependent. True, one advantage we have enjoyed, which is indeed worth all the organized instruction in the world which despotism could offer,—"although no science, fairly worth the seven,"—that of security for life and property; of the free exercise of thought and action; of a religion, which does not chain the energies of mind and character, but stimulates and exercises, while it regulates and directs them; and, though last, not least, that of a country to be proud of, and to be fond of, and which every one desires to bequeathe to his posterity better, more beautiful, and stronger than he found it. And it is by reason of this indirect influence on national character, that in spite of the more than want of encouragement of science of which our Government has been guilty, England has yet to boast of an array of men of science, of workers and discoverers, if not always of teachers, such as she need not be ashamed to show by the side of any other country, whatever stimulants or encouragements its Government may have supplied.

But, because so much has been done by the spontaneous vigour of the people's character and of their political and religious institutions, without special assistance or encouragement, does it follow that still more would not be done with those aids? Such, happily, is not the opinion of the present day,—not the opinion of the Legislature,—not that of our Universities themselvs. We do not believe that such difficulties are an advantage even to the vigour of the plant, still less to its extended propagation; and, accordingly, individuals, colleges, and, I hope, Governments, are now heartily and honestly engaged in repairing the deficiencies of centuries, and not only in promoting the general development of intellect, but especially in directing it to the fields of science. And happily, the facilities for the purpose, already at hand, are enormous. The Chancellor of the Exchequer need not apprehend excessive demands upon his treasury to meet the case; though, if they were necessary, I believe he is too sensible a man to withhold them: but such demands are not required. The encouragements and assistances already given by the State to the education of the people, in various shapes; the superior class of trained and examined teachers, who are spreading over the land, and whose training has in no small degree been in physical science; the books provided for early education by our Societies and by individual enterprise having the same character; the every-day more and more acknowledged connexion between agriculture and science showing itself in such papers as enrich the pages of the Journal of the Royal Agricultural Society; the establishment of the Department of Science, with its School of Mines under the Board of Trade; the improvement which is to be expected, under the action of the Charity Commissioners, in the system of our old grammar schools; the spontaneous action of our old Universities, not superseded, but facilitated and stimulated by parliamentary interposition:—these and such like changes, which are taking place, partly within the bosom of society itself, and partly by the action of Government, will shortly provide such means of scientific education, although not systematised with the exactness of Continental organization, as will, after our rough English fashion, adequately provide for all our wants in that respect, and give us no cause to lament over any considerable deficiencies in practical result.

But will there be encouragement to make use of these facilities? Are there rewards in prospect, whether of direct emolument or social consideration, which will induce men "to wear out nights, and live laborious days," in a service which has hitherto, in the world's eye at least, appeared often to be ill requited? Now, the real stimulant to science has at all times been the delights of the pursuit itself, and the consciousness of the great services rendered to humanity by every conquest within the domain of truth; but still these questions may fairly demand an answer. To the questions of pecuniary rewards I will presently advert; they have certainly been miserably inadequate; but in regard to social consideration, I think there has existed some misunderstanding. It has been often asserted, and made the subject of lamentation or complaint, that men of science do not enjoy in this free country the consideration which they do in some countries less favoured otherwise in their institutions than ourselves. Now, if by this it is intended to express that men of science are not made Knights of the Garter, or Peers of Parliament,—that they are not often met with in the haunts of wealth and fashion,—that they are not called into the councils of their Sovereign, or sent to represent her in foreign Courts, I admit the fact; but then I doubt whether these are the natural or fitting objects of ambition to the scientific man: and if it is intended by the assertion that they are not, as a class of individuals, appreciated by their fellow-citizens for their genius and honoured for their services, I cannot so fully admit the fact. I would ask any of those whose presence adorns this Meeting, do they not find that their names are a passport into any society, the proudest of the land? Whose doors, that are worth entering, are not open to them? There are certain advantages, superficially considered, which will always belong to mere wealth or power; but are they such as the lover of science can bring himself to envy or desire? Wherever he is known he is honoured—witness in themselves the Meetings of this great Association, and of other kindred bodies, who visit, from time to time, different quarters of our land: where is their presence not hailed, not struggled for? Where is it not the endeavour of rank and wealth on every such occasion to do honour to itself by showing honour generally and personally to those who, by their successful pursuit of science, have done honour to our own or foreign lands? If, indeed, there be anything yet wanting in this respect, either in our people or our Government, the progress of education in science, to which I have before alluded, will soon supply it. When the various classes of our population, in their schools, their mechanics' institutes, and, not least, in their colleges, are themselves less ignorant of science; when they have learnt to appreciate its value by personal acquaintance with its truths; there is no fear that those at whose feet they have sat—whose names are familiar to them in association with so valuable an acquisition—will not receive all due honour and regard. Whether, or to what extent, the result will be a greater association of science with political position, and how far such association would be advantageous to either politics or science, is another question. The experience of foreign countries on this head can hardly be held to be quite satisfactory. I am not sure that their men of science have been very successful politicians, or that science itself has profited by the union. Public life, not less than science, is a jealous mistress, and does not well tolerate a known devotion to any other pursuit. It has besides a science of its own, essential to it, especially in a free country,—the knowledge of men; and this is not always the special gift of men of science, who deal less with men than with things and thoughts; and I am not sure that the qualities, which fit a man for success in the one pursuit, are peculiarly advantageous to him in the other. This, however, is certain,—that those who administer the affairs of this country ought at least (I do not think as yet they do) to know enough of science to appreciate its value, and to be acquainted with its wants and with its bearings on the interests of society; but such knowledge, I cannot doubt, will soon become the common appanage of all well-educated men; and when it is so, as I said before, whatever, either in the position of science itself, or of men of science, is still wanting, will soon be supplied.

To accelerate, however, this process, I would gladly see a more direct communication established between the organs of power and scientific bodies. Something in this respect has already been done by the Parliamentary

Committee of this Association, and the results have been already seen in the increased attention of Parliament and Government to scientific objects. Still, however, in regard to science, I must admit that there is one great deficiency; for often may it be said of science, as was said satirically of virtue by the poet, *laudatur et alget*,—it is praised and starves. The man of science may not desire to live luxuriously; he may not (nor ought he) desire to rival his neighbours in the follies of equipage and ostentation, which are often, indeed, rather a burden imposed by the customs of society than an advantage or even a gratification to the parties themselves; but he must live; and for the sake of science itself he ought to be able to live free from those anxious cares for the present and the future or from the calls of a profession, which often beset and burden his laborious career. Why was our Dalton compelled to waste the powers of such an intellect on private teaching? As a teacher, a physician, or a clergyman, or more rarely as a partner in a profitable patent, such a man may earn a competence, and give to science the hours which can be spared from his other avocations; and it is indeed astonishing what results have been the produce of these leavings of a laborious life,—these leisure hours, if so they may be called, of men who are engaged in arduous duties of another kind. But this ought not to be; and it will not long be, I am confident. It must give way before the extended cultivation of science itself. The means of occupation in connexion with our schools and our colleges, and our examinations, will increase; and I cannot but hope that a grateful country will insist upon her benefactors in science receiving a more liberal share of her bounty than has hitherto been allotted them. If I recollect right, out of the 1200*l.* which are annually appropriated in pensions to the successful cultivation of science, literature, and art, a poor pension of 50*l.* is all that last year fell to the lot of science: and in former years the disproportion has often been little less remarkable. I do not grudge their share to Literature and Art; but I confess I cannot but consider that the labours of Science are at least of equal value to a nation's welfare; that they have at least an equal claim upon her gratitude, and I am sure that they stand in no less need of encouragement and support.

Nor have I any fear that the study of Science should ever become too exclusive, that it should make us too material, that it should overgrow and smother those more ethical, more elevating influences, which are supposed to grow from the pursuit of Literature and Art.

In the first place, the demands of Science upon the patient and laborious exercise of thought are too heavy, too severe, to make it likely that it should ever become the favourite study of the many. In Art and Literature the mind of the student is often comparatively passive, in a state of almost passive enjoyment of the banquet prepared for him by others; in the pursuits of Science the student must work hard for his intellectual fare. He cannot throw up his oars,

> And let his little bark attendant sail,
> Pursue the triumph, and partake the gale,

but he must tug at the oar himself, and take his full share in the labour by which his progress is to be made.

Nor, when I read the works of a Whewell, and a Herschel, and a Brewster, a Hugh Miller, or a Sedgwick, and a hundred others, the glory of our days, can I see any reason for apprehending that the study of Science deprives the mind of imagination, the style of grace and beauty, or the character of its moral and religious tone, its elevation and refinement.

And now, ladies and gentlemen, I have done. Once more assuming for a moment the character of a representative of this great town, I welcome you, the British Association, a second time to Liverpool. It is right that you and Liverpool should have frequent meetings, and should cultivate an intimate acquaintance. There is no place which can do more for science if she pleases; none has opportunities so extensive of becoming, by her ships and commercial agencies, by her enterprising spirit and her connexion with every soil and climate, the missionary of science,—perhaps in this place I should rather say the importer of the raw material of facts and observations,—the exporter of the manufactured results arising from their scientific discussion. There is no town which owes more to science. Without science can her vessels stir without danger out of sight of land, or walk the waters independent of wind or tide? Without science would they have docks to shelter them, railroads to bring their produce to their docks, telegraphs to announce their movements, manufactures to freight them to distant lands? I do not believe that Liverpool is insensible to her obligations. This magnificent reception is one evidence of the feeling,—but a still better is to be found in her liberal support to such institutions as the Public Libraries and Museums, as her Collegiate Institution and her Mechanics' Institute, and above all her magnificent Observatory.

Again I welcome the British Association for the Advancement of Science to the walls of Liverpool, fully assured as I am of the great benefits, direct and indirect, which their presence will confer upon the town, and of the deep sense which the inhabitants entertain of the honour conferred upon them by this repeated visit.

REPORTS

ON

THE STATE OF SCIENCE.

Third Report on the Facts of Earthquake Phænomena (continued).

By Robert Mallet, *C.E., M.R.I.A.*

Catalogue of recorded Earthquakes from 1606 B.C. *to* A.D. 1850.

[Continued from Report for 1853, p. 212.]

1. ANNO DOMINI.	2. *Locality.*	3. *Direction, duration, and number of shocks.*	4. *Phænomena connected with the sea.*	5. *Meteorological and other phænomena.*	6. *Authority.*
1784. Aug. 26.	At S^te^ Marie and Oléron in the Pyrenees.	A slight vibration ...	....	....	Palassou, *loc. cit.* p. 269.
—— —— 27. Between 9 and 10 A.M.	The village of Viel, a quarter of a league from Barèges in the Pyrenees.	Ditto	....	....	Ditto.
—— Sept. Beginning of the month.	Island of Cephalonia. Also in S^ta^ Maura, and at Argos.	Many severe shocks...	....	In Cephalonia much damage was done; but little however in S^ta^ Maura and at Argos.	Hamb. Corresp. Nr. 176.
—— —— 5.	Grenoble in France......	One shock	....	....	v. Hoff.
—— —— — At night.	Fortress of Rheinfels on the Rhine.	Two shocks	....	Accompanied by a loud explosion like the report of a cannon.	Mercure de France, 20 Oct.; Cotte.
—— —— 12.	Calabria Ultra...........	Repeated shocks......	On this day, about 9 A.M., an unusual agitation of the waters of Loch Tay in Scotland was observed. The movement was from E. to W., lasted a quarter of an hour, and was accompanied by noise. The phænomenon recurred on the five following days at about the same hour. No earthquake was observed in the neigh-	....	Gazette de France, 5 Nov.; Journ. Encycl. 15 Nov.; Hamb. Corresp. Nr. 171; Biblioth. Brit. t. vi. p. 184–187; Edinburgh Transactions, vol. i. p. 200.

9 P.M.					
— — 12.	Calabria Ultra	A severe shock		More damage was done. "Dr. Maret, in his account of the following earthquake at Dijon, only admits this shock as real, and rejects the accounts of those on the 12th September" (Perrey quoting Mém. de l'Acad. de Dijon, 1784, p. 79).	Ditto, 6 Nov.
— — 15. 12^h 2 or 3^m noon.	Dijon, Tournus, Châlons, Autun, Charelles, Besançon, Lons-le-Saulnier, Geneva, and Valence. Also at Grenoble, in the valley of Graisivaudan, at Chambéry, at Bourg-en-Bresse, and at Aix in Savoy.	At Dijon rather a slight shock. The oscillation appeared to be in the direction S.E. to N.W. at most of the places mentioned; at Grenoble it was violent, and from E. to W. It was still more violent in the valley of Graisivaudan, as far as Chambéry at Bourg, and at Aix in Savoy.		The weather at Dijon was calm and fine, and was not immediately altered, but in a few days it became rainy, and continued so (with some snow) for some time. Two peasants on a ladder were thrown down at the bridge of Beauvoisin. At Bourg-en-Bresse the shock was accompanied by a noise like that of a blast of wind, although the atmosphere was quite calm. At this place the barometer suddenly fell three lines, and rose immediately after the shock to its former level.	Mém. de l'Acad. de Dijon, 1784, p. 65; Gaz. de Fr. 2 Nov.; Merc. de Fr. 6 Nov.; Journ de Paris, 28 Oct.
— — 17. In the evening.	Naples	Two shocks		On the 24th Vesuvius began to send forth smoke, &c.	Merc. de Fr. 27 Nov.
— — 22.	Altamora and some other places in Calabria.	Several shocks			Hamb. Corresp. Nr. 193.
— Nov. 9.	Briançon	One shock			Cotte.
— — 12.	In the bishoprick of Spires.	Violent shocks		A high wall of 7 feet in thickness was thrown down at the castle of Kropsberg.	Merc de Fr. 18 Déc.
— — 13.	Arequipa in Peru	An earthquake			Cotte.
— — 29. 10 P.M. 10^h 10^m. ...	Bourlemont, half a league from Neufchâteau (depart. Vosges), and at Clefmont (depart. Haute Marne). Also Strasbourg, Bâle, Berne, and all the southern part of Alsace; and in Dau-	At Bourlemont a violent shock of a minute's duration. At Strasbourg, &c. in Alsace, several shocks, lasting 4 or 5 secs., and in the direction S.W. to N.E.		The barometer was observed to fall below "stormy," not only in the region where the earthquake was experienced, but also at Paris where nothing was felt.	Mém. de l'Acad. de Dijon, 1789, p. 79; Merc. de Fr. 18 Déc., 1 Janv. 1785; Éphém. de Mannheim, 1784, p. 458; Gazette de Leyde, 21 Déc.; v. Hoff.

1.	2.	3.	4.	5.	6.
	phiny and Savoy, at Geneva, in the Canton de Vaud, and in Germany, over a space of more than 150 leagues.				
1784. Dec. 3. 4 P.M.	In the valley of Graisivaudan, on the road from Grenoble to Chambéry, and in the mountains separating this valley from La Maurienne. Also at Barreaux and Allivand.	Several shocks from *N.E. to S.E.*		Preceded by a subterranean noise	Merc. de Fr. 25 Déc.; Mém. de l'Acad. de Dijon, 1784, p. 79; Cotte.
—— —— 4. 3, 4 and 5 P.M.	Prague	Slight shocks from *E. to W.S.W.*			Éphém. de Mannheim, 1784, p. 680.
—— —— 5. 11¼ P.M.	Neufchâteau, Rouceux, Noncourt, and Bourlemont (department Vosges).	A violent shock		Some walls and a house were thrown down. A violent wind arose at the time of the earthquake, and blew for thirty-six hours. The barometer fell six lines at Paris the night before. (May not this allude to the event of the 29th Nov.?)	Journ. de Paris, 24 Déc.
—— —— 6.	On the English coasts	Several shocks			Cotte.
—— —— 9.	Briançon (department Hautes-Alpes).	A rather severe shock.		Accompanied by a low noise. For some days burning vapours had been observed rising from the earth, beneath which there were deposits of coal. Very probably this is but the same event with that before given as occurring on the 9th Nov.	Merc. de Fr. 8 Janv. 1785; Mém. de l'Acad. de Dijon, 1784, p. 79.
—— —— 21.	Calabria Ultra	Shocks of great violence again, lasting some minutes.			Gaz. de Leyde, 1785. Nr. 11, Suppl.; Journ. Encycl. 1 Mars 1785.
—— —— 28.	Around Vesuvius, and as far as Naples.	Vibratory shocks		Accompanying an eruption of the upper crater of Vesuvius, which lasted until the following February, but did little damage.	Hamb. Corresp. 1785. Nr. 8 u. Nr. 44.
—— —— Night between 29 and 30.	Fürstenau in the county of Erbach.	Two violent shocks, lasting 1 min. each.			Merc. de Fr. 29 Janv. 1785.

1785. Jan. 11. 4 P.M.	Klagenfurth in Carinthia.	One shock	....	....	....
—— —— Night between 23 and 24.	In various Danish islands, particularly in Sœbye.	Several slight shocks.	....	Cotte gives the date 28th January	Merc. de Fr. 5 Mars; Cotte.
—— —— 31. At midnight.	Klagenfurth again	Two more shocks ...	....	The air was calm, and it rained heavily	Merc. de Fr. 5 Mars; Éphem. de Mannheim, 1785, p. 580; Hamb. Corresp. Nr. 30.
—— Feb. 4.	In Calabria	More violent oscillations.	....	Fresh damage done	Merc. de Fr. 26 Mars; Journ. Encycl. 15 Avril; Hamb. Corresp. Nr. 44.
—— —— 13.	Ditto	Another earthquake..	....	Buildings were again thrown down	Éphém. de Mannheim, 1785, p. 581; Hamb. Corresp. Nr. 52.
—— —— 19. Between 7 and 8 A.M.	Lisbon......	A slight vibration ...	....	The Hamburger Correspondent gives the date 20th February.	Éphem. de Mannheim, 1785, p. 581; Hamb. Corresp. Nr. 51.
—— —— 23. 2h 2m A.M.	Mosdock on the Terek, and the country round, and at Kislar. Also at Astracan, and the environs.	A violent shock at Mosdock, lasting two minutes, followed in an hour by a second of equal violence and duration, and between 7 and 8 P.M. by a feeble one. At Astracan three violent shocks.	The water of the Terek was strongly agitated.	The first shock was accompanied by a subterranean noise like thunder. The second threw down the sentinels. The Éphém. de Mannheim gives the date 24th February for the shocks at Astracan.	Hamb. Corresp. Nr. 70; Gaz. de Leyde, Nr. 37; Merc. de Fr.; Éphém. de Mannheim, p. 582.
—— —— 24. 1 A.M.	Mosdock again	Another shock, as violent as either of the first two.	....	....	Ditto.
—— —— 26.	Island of St. Thomas in the West Indies.	An earthquake	....	Probably the same earthquake with one mentioned (without date) in a letter to the Hamb. Corresp. Nr. 56, dated London, 29th March, as having been felt in Barbadoes, Grenada, and Trinidad.	Hamb. Corresp. 1785. Nr. 99.
—— —— End of the month.	Patras. Also in the island of Zante.	A violent and destructive earthquake.	....	Vesuvius was in violent eruption during the greater part of this year.	Ditto, Nr. 71; Gaz. de Leyde, Nr. 35; v. Hoff.
—— Mar. 17.	Messina	Another shock	....	The few houses that remained standing before this, were thrown down. On the 13th of this month a sort of small volcanic eruption took	Merc. de Fr. 7 Mai; Journ. Encycl. 1 Juin, 1785; Gaz. de Fr. 13 Janv. 1787; Hamb. Corresp. Nr. 70.

1.	2.	3.	4.	5.	6.
				place in the river Majuri (province of Salerno); on the 11th the river Teviot in Scotland dried up suddenly, and remained dry for two hours (the weather being very cold, and the stream covered with ice); and on the 31st at Commotace in Bohemia there occurred a great fall of a mass of earth. There is no proof, however, of any of these phænomena having been attendant on earthquakes.	
1785. April 2. 4h 20m A.M.	Nordenstadt near Darmstadt. Also felt at Mayence, and still more at Schelestadt.	A severe shock			Merc. de Fr. 30 Avril et 7 Mai.
—— —— —	Eglisau in the canton of Zürich.	A vibratory shock			Hamb. Corresp. Nr. 60; Éphém. de Mannheim, p. 586.
—— —— Night between 2 and 3.	Mayence	Several shocks		Probably this and the last two events occurred nearly, if not exactly, at the same time.	Hamb. Corresp. Nr. 58.
—— —— 10.	Mexico, and several other districts of New Spain.	Violent earthquake shocks.			Mémorial de Chron. t. ii. p. 932.
—— —— 20.	Fiume in Italy	Several shocks			Hamb. Corresp. Nr. 82; Cotte.
—— —— 21.	Mont-Dauphin in Dauphiny.	One shock			Cotte.
—— —— 26. 5 and 9 P.M.	Smyrna	Two shocks			Hamb. Corresp. Nr. 96.
—— —— 29. 11 A.M.	Mont-Dauphin again	Two consecutive shocks lasting five to six seconds.			Merc. de Fr. 4 Juin.
—— May 5. Midnight.	Grenada in Spain	An earthquake of two minutes' duration.			Hamb. Corresp. Nr. 92.
—— —— 13. About half an hour after midnight.	Naples	Several shocks			Ditto; Merc. de Fr. 18 Juin.
—— —— 20.	Fiume in the Gulf of Venice.			Preceded by a subterranean noise. In all probability the same event with that recorded on the 20th April, but which date is the correct one I cannot say.	Gentleman's Magazine, vol. lv. p. 663.

1785. May 20.	In Surinam, S. America.	An earthquake	......	[illegible]	
Night between 24 and 25.	[illegible]	[illegible]		[illegible]	
—— June 5.	Velletri in Italy	A severe earthquake..	......	......	Ditto, Nr. 106.
—— —— 21. (Before this date.)	Calabria	The shocks continued in Calabria, according to letters of this date from Naples.	......	At Vevay a piece of ground sank during this month, and many houses upon it. No shock mentioned. (Hamb. Corresp. Nr. 102.)	Ditto, Nr. 108.
—— July 11. 3 A.M.	Island of Antigua. Also in the island of St. Christopher, and Tortola.	The most violent shock ever known up to that time in Antigua.	The shocks were also felt on board the ships in the neighbourhood of these isles.	In Tortola the earthquake made great clefts in the rocks, and separated completely a part of the island, forming a new island.	Gazette de Leyde, Nr. 74; Hamb. Corresp. Nr. 153; Cotte.
—— —— 12. 8 A.M.	Santa Fé de Bogota ...	An earthquake	......	Two churches were thrown down......	Hamb. Corresp. Nr. 191; Annual Register.
—— —— —— and 20. (At periods before these dates).	In Calabria	More shocks, according to letters from Naples of the dates given.	......	......	Merc. de Fr. 13 Août; Hamb. Corresp. Nr. 128.
—— —— 18.	Clausemberg in the basin of the Danube.	An earthquake	......	During rain. The evening before, Dr. König suspected the probability of shocks from observing some considerable magnetic perturbations.	Éphém. de Mannheim, 1785, p. 603?
—— —— 19. About 11ʰ 20ᵐ P.M.	Padua	A slight shock, ending by an oscillation from S. to N.	......	......	Ditto, p. 457.
—— —— 23. or 25, 1 A.M.	In Upper Austria, at Steierregg, St. Georgen, Pulgarn, and other places.	Several shocks. Another, but slighter, at 6 A.M.	......	......	Hamb. Corresp. Nr. 126.
—— —— 26.	Triente in Italy. Also at Padua.	A rather violent shock.	......	Followed by heavy falls of rain, which caused inundations of the Adige and other rivers. The Éphém. de Mannheim (p. 592) gives the date 2nd August.	Merc. de Fr. 10 Sept. et 8 Oct; Hamb. Corresp. Nr. 138.
—— —— 29.	Port-au-Prince in St. Domingo.	A violent earthquake.	......	It was remarked that this city experienced earthquakes every seventeen or eighteen years.	Merc. de Fr. 1 Oct.; Gaz. de Leyde, Nr. 79, Suppl.
—— Aug. 6.	Payo in Spain	Several shocks	......	......	Cotte, *loc. cit.*
—— —— 22. 6¼ or 6¾ A.M.	In Moravia and Silesia. Besides the places mentioned in the next	A severe vibratory shock. It was slight and lasted fifteen	......	Some houses were thrown down at Ratibor and Pless. Part of the river Biala disappeared. At Sorau the tower of the Rathhaus was so	Merc. de Fr. 24 Sept. et 1 Oct.; Éphém. de Mannheim, p. 594; Hamb. Corresp. Nrs. 144, 146,

1.	2.	3.	4.	5.	6.
	column, Sorau, Misteck, Frideck, and Skotzan are mentioned.	seconds at Cracow, Vator, Lipov, Krussowika, Morawika, and Bolecho.		shaken that the bell was struck, and sounded. The Éphém. de Mannheim gives the date 24th August, and attributes the earthquake to inundations of the Oder having undermined the ground. On this day a piece of ground sank at Jarmolin near Sanock in Poland. Irregularities of the magnetic needle were observed in Germany, both before, on, and after this day.	154; Gazette de Leyde, Nr. 66.
1785. Aug. 22.	In several parts of Italy.	Several shocks			Cotte.
—— —— 29.	Smyrna	A slight earthquake...			v. Hoff.
—— Sept. Night of 11–12 (according to others, of 10–11).	Briançon in Dauphiny. Also at Grenoble, and very severely at Susa in Piedmont.	At Briançon 2 shocks in two minutes. At Grenoble their direction was N. to S.	On the 6th an extraordinary rising of the sea took place at La Rochelle. No shock mentioned. (Éphém. de Mannheim, p. 723.)	At Briançon accompanied by subterranean noise. No damage done. At Susa in Piedmont two houses fell. Some days before, the atmosphere was very hot, and full of vapours. This was the third earthquake this year at Briançon.	Merc. de Fr. 1 et 8 Oct.; Gazette de Leyde, Nr. 81, Suppl.; Hamb. Corresp. Nr. 162; v. Hoff.
—— —— 22. 7 A.M.	Cracow in Poland	Three shocks from W. to E.			Merc. de Fr. 17 Déc.; v. Hoff.
—— Oct. 1. 4 A.M.	Rome	Two shocks, followed by a third of more violence at 7 A.M.			Hamb. Corresp. Nr. 171.
—— —— Night between 1 and 2.	At Linz, and at Gallneukirchen and other places in the neighbourhood.	Three rather strong vibrations.		The walls were cracked	Ditto.
—— —— 2. 10 P.M.	Rome. and still more at Tivoli, Frescati, Marino, Castel-Gandolfo, Spoleto, Rieti, and Terni, to the distance of sixty miles from Rome, upon the side of the Apennines.	Two or three violent shocks.		At the same time some drops of rain fell for a few minutes.	Ditto; Merc. de Fr. 28 Oct. et 10 Déc.; Journ. Encycl. 1 et 15 Déc.; Éphém. de Mannheim, p. 158.
—— 3. About $9^h 15^m$	Ditto. Also (on same day, but hour not mentioned) at Venice.	Three or four shocks, lasting seven or eight minutes.		On the same day a spot of ground of 24 feet in diameter, sank in the depart. Seine-et-Oise in France to the depth of 24 feet. No shock mentioned. (Merc. de Fr. 10 Déc.; Gaz. de Fr. 11 Mars, 1786.)	Ditto.

1785. Oct. 9. 4 A.M.	Rome. Also felt at Norcia. Also on this day (hour not given) at Venice.	Three undulatory shocks from N.E. to S.W., lasting twenty seconds. The first was from below upwards. They were more violent, and extended further than the former. At Norcia they were followed by others at 4^h 30^m, scarcely perceptible at Rome.		It rained at Norcia the whole of the rest of the day. The Hamb. Corresp. gives the date 8th October.	Hamb. Corresp. Nr. 171; Merc. de Fr. 28 Oct. et 10 Déc.; Journ. Encycl. 1 et 15 Déc.; Éphém. de Mannheim, p. 158.
—— —— 11.	Terni. Also on this day at Venice again.	Another shock		Processions were instituted in order to the cessation of these shocks.	Ditto.
—— —— 13.	Rome	An instantaneous and scarcely perceptible shock.			Ditto.
—— —— 14.	Terni and Tivoli	More shocks			Ditto.
—— —— 15.	Terni	Twelve shocks in the space of four hours.		At Pie-di-Lugo (probably the centre of this disturbance) several small fumaroles opened, from which there came forth smoke and an odour of sulphur.	Ditto.
—— —— —	In Thuringia; felt at Kahla, Jena, Weimar, Burgel, and as far as Nordhausen.	A vibratory shock from S. to N.		Ended with an explosion. The atmosphere was hot, and a fire-ball was observed.	Hamb. Corresp. Nr. 176–178.
—— —— 27.	Venice	Several shocks			Cotte.
—— Nov. 5. About sunset.	Terni again	Another shock			Éphém. de Mannheim, p. 158, and Append. p. 80; Gaz. de Fr. 3 Fév. 1786.
—— —— 9.	Tangiers	A rather violent earthquake.			Hamb. Corresp. Nr. 208.
—— —— 12. 1 A.M.	Terni again	Another shock		It rained in the evening	Éphém. de Mannheim, and Gaz. de Fr. *loc. cit.*
3 A.M.	Rome	A slight shock.			
—— —— 16. 10 P.M.	Spideberg in Norway	An earthquake shock.			Éphém. de Mannheim, 1785, p. 556.
—— —— 22.	Lisbon	A slight earthquake			Hamb. Corresp. 1786, Nr. 3.
—— —— 25.	Terni again	Several more shocks.		Rain during the following evening and night	Éphém. de Mannheim, p. 158, and App. p. 80; Gaz. de Fr. 3 Fév. 1786.

1.	2.	3.	4.	5.	6
1785. Nov. 29. About sunset.	Terni again	Several more shocks.		Rain during the day	Éphém. de Mannheim, p. 158, and Append. p. 80; Gaz. de Fr. 3 Fév. 1786.
—— Dec. 4. At night.	Ditto	Ditto		Rain before, during, and after the shocks	Ditto.
—— —— 10, or 18 (v. Hoff thinks the 18th most probably the correct date).	Clermont and Riom in Auvergne.	A rather severe shock.			Cotte; Hamb. Corresp. 1786, Nr. 2.
—— —— 16. From 8 P.M. to 3 P.M. the following day.	Terni again. Also perceptible at Padua.	Numerous shocks in this space of time.			Éphém. de Mannheim, and Gaz. de Fr. *loc. cit.*
—— —— 20.	Terni again	More shocks		It rained at this place almost every day during the month.	Ditto.
—— Towards the end of the year.	Iceland	Many earthquake shocks.		Accompanying a new volcanic eruption	Gaz. de Fr. 24 Fév. 1786, quoting a letter from Copenhagen of the 30th January.
——	Comorn in Hungary	An earthquake			Abh. der Böhmischen Gesellschaft der Wissenschaften, 1785, Abth. 1. S. 107.
——	Baltimore, United States	An earthquake			v. Hoff.
1786. Jan. 1.	Terni again	Another vibration		It rained almost the whole day	Éphém. de Mannheim, 1786, p. 496; Gaz. de Fr. 3 Mars.
—— —— 2. 7^h 15^m A.M.	Baltimore and Cambridge, United States.	An earthquake shock			Éphém. de Mannheim, 1786, p. 572; Cotte.
—— —— 3. In the even^g.	Stettin	Ditto			Éphém. de Mannheim, p. 569.
—— —— 6. 9^h 30^m P.M.	Rome	A scarcely perceptible shock.			Ditto, p. 496; Gazette de France, 3 Mars.
—— —— 15. 5½ and 8½ A.M.	Gubbio (eight posts from Terni, in the Romagna).	Rather smart shocks			Ditto.
About noon	Rome	A slight shock		This month, like the preceding, was very rainy, especially towards the end.	Ditto.
—— —— — Hour not given	Szathmar in Hungary	Some slight shocks			Gazette de France, 24 Mars.

1786. Jan. 30. 8 P.M.	Smyrna	A slight earthquake			Hamb. Corresp. Nr. 46.
—— Feb. 5.	Corfu	An earthquake		According to the Mercure de France (13 Mai), this earthquake ruined a great part of a town and caused the death of 120 persons. No date (as to month or day) is given, but it obviously refers to this event.	Gentleman's Magazine, vol. lvi. p. 262.
—— —— 12. 5h 30m A.M.	Reate (now Rieti) in the Romagna. Also on this day (hour not given) at Terni; and about this time at Gubbio.	A vibration at Reate. At Terni a very severe shock; and at Gubbio every day about this time three or four shocks were experienced. How many on this day is not said.			Éphém. de Mannhein, p. 498; Gazette de France, 24 Mars.
—— —— 13. Midnight.	Albstadt (Swabia), Schreiberseisen and Diversdorf.	Several shocks			Gazette de France, 24 Mars, quoting the "rubrique" of Hamburg of the 24th February; Cotte.
—— —— 15.	Clausenburg in Transylvania.	A violent earthquake		Four churches were thrown down, and much damage was done besides.	Hamb. Corresp. Nr. 46; Gazette de France, 28 Mars.
—— —— 24. 1 A.M.	Terni again	A slight vibration		It rained on the following days	Éphém. de Mannheim, p. 499.
—— —— 27. 4 A.M. 4 A.M. 12½ midnight and 4 A.M. 4h 15m 4h 20m	Very widely extended, being felt all over Upper Silesia, Poland, Hungary, Moravia, and Bohemia; principally along a line drawn from Brünn to Cracow (*i. e.* 35 geographical miles in a S.W. to N.E. direction). On this line it was felt at Brünn, Keltsch, Schwechwitz, Schwanowitz, Misteck, Friedeck, Teschen, the Polish Ostrau, Neuhübel, Bielitz, at Tribau, and at Cracow. Also,	Violent but not very destructive shocks. At Keltsch the earth was agitated for a quarter of an hour. At Schwanowitz two shocks were felt at the hours mentioned, the second (at 4 A.M.) being the more violent. At Bielitz, two hours before, a slighter shock had been felt, and another similar one at 8 P.M. the evening before. At Okolicsna 3 shocks		At Schwechwitz a cleft opened in a church. At Bielitz subterranean thunder was heard. At Altheida a little river disappeared suddenly. In the mines of Tarnowitz and Wieliczka nothing was felt. The weather was hot, and the air calm, but in Hungary a violent storm succeeded the shock.	Hamb. Corresp. 1786, Nrs. 41, 43; Gazette de France, 31 Mars, 14 et 18 Avril; Éphém. de Mannheim, 1786, p. 570.

1.	2.	3.	4.	5.	6.
$4^h 15^m$ 4 A.M.	off this line, in Hungary at Okolicsna, Smercan, and Poturnya; and in Bohemia at Königsgräz.	were perceived. The general direction was from W. to E.			
1786. Mar. 4. Between 3 and 4 A.M.	Falkenberg in the province of Halland in Sweden.	Several severe shocks		During a season of intense cold	Gazette de France, 28 Avril; Cotte.
—— —— 9.	In Sicily, at Patti and the district around, S. Pietro, S. Tindaro, Melazzo, and Messina.	An earthquake		Part of Melazzo was very much ruined	Hamb. Corresp. Nrs. 65, 81.
—— —— 10.	In the Palatinate and Voigtland. extending from Nöilas to Lobienstein.	Vibratory shocks			Gazette de France, 7 Avril; Éphém. de Mannheim, p. 570; Cotte.
—— —— 24, and earlier.	In Arnes-Syssel, Iceland.	An earthquake			Hamb. Corresp. Nr. 84.
—— —— — 10 and 11 P.M.	Bonn on the Rhine	Two shocks at these hours.		These shocks are very probably the same with the following.	Cotte.
—— —— 28.	Bonn and the neighbourhood.	Several shocks			Gazette de France, 21 Avril.
—— April. Night, between 6 & 7.	Milan, Liscate, and the neighbourhood.	Ditto		At Liscate some old houses were thrown down.	Hamb. Corresp. Nr. 67; Éphém. de Mannheim, p. 318; Gaz. de Fr. 9 Mai.
—— —— 7. 2 A.M. Hour not given.	Padua and Bergamo. Also at Crema and Placenza.	At Padua a slight shock from N. to S. It was very severe at Bergamo. At Crema the shock was slight, but stronger at Placenza. It seems doubtful whether there was but one shock varying in intensity at the different places, or whether there were several.			Ditto; Hamb. Corresp. Nr. 69.

					Corresp. Nr. 79.
— — 13.	Milan	A trembling			Cotte.
— — 22. 8½, 10, and some minutes past 11 P.M.	Bonn, and the adjacent banks of the Rhine.	Several shocks		Cotte gives the date 21st April	Gazette de France, 16 Mai; Cotte.
— May 23. Between 1 and 2 P.M.	Terni in the Romagna again.	Another slight vibration.			Ephém. de Mannheim, pp. 503–509.
— — 30. 1 A.M. and 9 P.M.	Ditto, extending as far as Rome.	More shocks		At Rome the shocks were perceived by everyone	Ditto.
— June 1.	In Iceland	A shock unproductive of damage.	Felt by Admiral Löwenörn on board his vessel in the harbour of Raikianess.		Hertha von Berghaus, B. 3. S. 703.
— — 4. 10 A.M.	Rome and Terni	At Rome a slight undulatory shock, more severe in the environs of Terni.		Followed by rain	Éphém. de Mannheim, *loc. cit.*
— — 13.	Spoleto and all the plain between Terni and the foot of the Apennines.	Another vibration		Ditto	Ditto.
— — 14.	Terni and San-Gemini	More shocks		Some damage was done at San-Gemini	Ditto; Hamb. Corresp. Nr. 105.
— — 16.	Whitehaven, the south of Scotland, the Isle of Man, and at Dublin.	An earthquake			Thomson's Annals of Philosophy, vol. viii. p. 366.
— — 30.	Rome, Sabina, Monteroborde, and other places in the States of the Church.	Several shocks			Éphém. de Mannheim, *loc. cit.*; Hamb. Corresp. Nr. 101.
— July 8. About 6 A.M.	Buda, Comorn, &c., from the Upper Danube to the counties of Odimburg and Eisenburg.	Shocks, continuing for several days after.		It rained at 6 P.M.	Gazette de France, 12 Sept.; Éphém. de Mannheim, p. 87.
— — 10.	St. Goar on the Rhine	One shock			Cotte.
— — 22.	Ofen and Comorn in Hungary.	Ditto			Ditto.
— — 24. 12h 8m midnt.	Bonn	A shock of two seconds' duration.		The atmosphere was hot and calm	Hamb. Corresp. Nr. 120.

1.	2.	3.	4.	5.	6.
1786. July 30. $7^h\ 6^m$ A.M.	At Flekkertord, and in the western part of Norway.	Three shocks during $2\frac{1}{2}$ seconds.	....	....	Gazette de France, 26 Sept.; Éphém. de Mannheim, p. 404; Cotte.
—— —— — 4 P.M.	Rome, Rieti, Aquila, and Naples.	A shock, much more severe at Rieti and Aquila than at Rome.	....	The weather was lowering all day	Éphém. de Mannheim, pp. 503–509; Cotte.
—— —— 31. 5 A.M.	Egra, 7 (Norwegian?) miles to the west of Spidberg in Norway.	Another earthquake shock.	....	....	Gazette de France, 26 Sept.; Éphém. de Mannheim, p. 404.
—— Aug. 1 to 8.	Aquila again. The centre of these shocks appeared to be at Lucoli.	Forty shocks during this period. On the 22nd of September they had not ceased at Aquila.	....	At Lucoli a noise was heard like boiling under the earth.	Hamb. Corresp. Nrs. 143, 151, 163.
—— —— 5.	Lisbon	A slight earthquake...	....	....	Ditto, Nr. 148.
—— —— 11. A few minutes before 2 A.M.	Whitehaven, Lancaster, Cartmell (in Cumberland), Newcastle, Glasgow, the Isle of Man, and at Dublin.	At Whitehaven several shocks were felt, lasting three to five seconds. Supposed direction = S.E. to N.W. At Newcastle two shocks were felt, with an interval of three or four seconds.	....	Preceded by a rumbling noise. The weather close and sultry. Barometer = 29 inches. Several buildings, chimnies, &c. were thrown down. Some people also were thrown off their feet, and birds from their perches. At some places violent rain succeeded the shock. The Annual Register gives the date 1st August, but the discrepancy manifestly arises merely from difference of style. The Hamb. Corresp. (Nrs. 138, 146) records an earthquake with precisely the same details as this, on the 14th as felt at Cockermouth, Whitehaven, Workington, Maryport, Keswick, Carlisle, Kendal, and slightly in Aberdeen. The event seems certainly the same as that here recorded.	Annual Register, vol. xxix. p. 38; Gazette de France, 4 Sept.; Phil. Trans. vol. lxxvii. p. 35.
—— —— 19.	Carthagena in Spain ...	One shock	....	....	Cotte.
—— —— 22. 7 A.M.	Christianstadt in Norway. (According to Keilhau, Christiansand.)	Some slight shocks...	....	....	Gazette de France, 6 Oct.; Cotte; v. Hoff.
—— —— —	In Upper Silesia and Moravia.	Vibratory shocks......	....	....	v. Hoff.
—— —— 25.	In the Markgravate of Mainburg in the Bavarian Palatinate.	A trembling shock ...	....	....	Hamb. Corresp. Nr. 149.

1786. Oct. 13 and 14.	Aquila again	More shocks		Churches were injured, and tombs broken open, so that a pestilential smell came forth.	Gazette de France, 29 Sept. et 28 Nov.; Cotte.
—— —— 22. $11^h\ 30^m$ P.M.	Rome and Terni	A slight shock at Rome, more perceptible at Terni.			Éphém. de Mannheim, p. 507.
—— Nov. 1. At night.	Terni	Several shocks		It rained on the following days. From the 31st October to the 6th November Vesuvius was in eruption.	Ditto.
—— —— 18. $10^h\ 20^m$ A.M.	La Rochelle in France	A slight shock			Ditto, 1782 (?), p. 362.
—— —— 20. Between 3 and 4 A.M.	Bâle	Two slight shocks			Hamb. Corresp. Nr. 194; Merian.
—— —— 25. 5 and 11 A.M.	Rome and Terni	At Rome slight shocks, more perceptible at Terni.		v. Hoff merely mentions a shock at Rome on the 24th.	Éphém. de Mannheim, p. 507.
—— —— 29. 4 P.M.	Cambridge, United States.	Another earthquake shock.			Ditto, p. 590.
—— Dec. 2.	Aix in Provence	One shock			Cotte.
—— —— 3. $4^h\ 56^m$ P.M.	In Silesia, at Breslau, Brieg, Neisse, Lobschütz, Ratibor, Ramslau, Cracow, and other places in Poland, Hungary, and Galicia.	Several shocks. At Tarnowitz and some other places there were three, from the S.W.		At Zylo, in the county of Zips, bells sounded of themselves. At Tarnowitz some houses were injured. The air was calm. The disturbance was very strongly felt in the Carpathian Mountains. At the beginning of this month a cleft appeared in a mountain near Semlin, from which torrents of water came. No shock mentioned.	Gazette de France, 9, 12, 19 et 26 Janv. 1787; Cotte; Hamb. Corresp. Nrs. 199, 201.
—— —— 24. $7^h\ 30^m$ A.M.	Rimini	Several shocks		Most of the houses were injured	Éphém. de Mannheim, p. 510; Gaz. de Fr.
—— —— 25. 2 A.M.	Padua, Florence, Venice, Ferrara, Mantua, Faenza, Bologna, and especially at Rimini.	At Padua a very severe shock from N. to S. It was as violent at Florence, where another similar one was felt at 5 A.M. At Rimini the most violent shocks were felt, and they recurred here at intervals until the following February.		At Rimini there seems to have been thunder and lightning. Snow fell very thickly there. Many buildings were thrown down at this place.	Éphém. de Mannheim, p. 510; Gaz. de Fr. 19, 26 Janv., 2 Fév. 16 Mars, et 10 Avril, 1787; Hamb. Corresp. 1787, Nr. 8, 9, 18; Cotte.

1.	2.	3.	4.	5.	6.
1786. About this year.	Island of Java, particularly in the district of Batur.	An earthquake which lasted four months.		Great clefts opened in the earth, from which sulphurous vapours came out. In other places the earth sank, and produced chasms, into one of which the river Dotog-Bach flowed, and in future followed a subterranean channel from this place. The village of Djampang was swallowed up, with eighty-eight of its inhabitants, who had not time for escape.	Horsfield, Batav. Trans. vol. viii. p. 141; Lyell's Geology.
1787. Jan. 5. 3, 7 and 8 P.M.	Edsberg in Norway	Scarcely perceptible shocks at these hours.			Éphém. de Mannheim, 1788, p. 394.
—— —— 6. Between 10 and 11 A.M.	Camosie (or Campsie) and Strathblane, ten miles north of Glasgow.	A pretty smart shock		No damage done. A pair of horses attached to a carriage stopped suddenly at the moment of the shock.	Hamb. Corresp. 1787, Nr. 22; Gaz. de Fr. 9 Fév.
—— —— 21.	Griganti and the neighbourhood of Avellino, as also at S. Marino, Italy.	An earthquake		Did most damage at S. Marino. During the whole of this month Vesuvius was more or less in a state of eruption. On the 25th the river Teviot in Scotland again (see 11th March, 1785) dried up suddenly, and remained dry for four hours; the water afterwards returning, and flowing as usual. The weather was mild.	Hamb. Corresp. 1787, Nr. 21, 23; Gaz. de Fr. 13 Fév.
—— Feb. 25. 1 A.M.	Cambridge, United States.	A slight vibration, not remarkable.			Éphém. de Mannheim, 1787, p. 350.
—— ——	Rimini in Italy	The shocks continued here during this month.			Gazette de France, 16 Mars, 10 Avril.
—— March 3.	Florence, Rimini, Padua, and Venice.	Several shocks			Hamb. Corresp. Nr. 48; v. Hoff.
—— —— 14.	Acapulco	A violent earthquake.	The sea retired as far as some rocks lying in the middle of the bay. The galeon of the Philippine Isles, which was moored in 10 fathom water, found but 4 fathoms when the sea had retreated.	The city was ruined	Dupetit-Thouars, *loc. cit.* t. ii. p. 213.

		some seconds each.			Leyde, No. 34, Suppl.; Gaz. de Fr. 15 Mai.
——— 24 Between 7 and 8 P.M.	Radstadt, Forstan, *Flachau*, and St. Martin in the Salzburg Alps.	An earthquake			Hamb. Corresp. Nr. 58.
— April 17. 1 P.M.	Terni again	A slight shock			Éphém. de Mannheim, p. 224.
——— 18. In the morning.	In Mexico, extending from San Luigi de Potosi to Oaxaca, and from Vera-Cruz to Acapulco and Valladolid.	Earthquake shocks from the S.E. At the city of Mexico the earth was in almost continual agitation for 24 hours.	At Acapulco the sea retreated far from the shore, and then returned high above its former level. From this circumstance it seems probable that the event of the 14th March has either been confounded with, or was the same as this.	The city of Oaxaca was most injured	Hamb. Corresp. Nr. 137, Beil.
——— 29 and 30.	Messina	Two violent vibratory shocks.			Gazette de France, 5 Juin; Cotte.
——— In the course of the month.	In Puglia and the Abruzzo.	Several shocks			Gazette de France, 8 Juin.
— May 6.	Messina and Naples	A very severe shock at Messina. Both this and the following were more violent than those of the 29th and 30th April.			Hamb. Corresp. Nr. 95.
——— 13.	Ditto	Another shock		During this month a cleft opened in the Heuberg near Rebshausen. No shock mentioned (v. Hoff).	Ditto.
— July 6. In the morning.	Penrith, Threlkeld, and Keswick in Cumberland.	One shock		Some masses of rock were detached by the shock	Gazette de France, 17 Août; Cotte.
——— 12.	Near Vichely in the county of Semplin, Hungary.			Two mountains were suddenly levelled. No earthquake is mentioned, and the phænomenon may have been nothing more than a great landslip.	Gazette de France, 3 Août.

1.	2.	3.	4.	5.	6.
1787. July 16. In the morning, and in the afternoon.	Ferrara........................	Two shocks at these two periods of the day. Both were slight.	....	....	Gazette de France, 24 Août; Éphém. de Mannheim, p. 224.
—— —— 17. $2^h\ 30^m$ P.M.	Braga in the province of Minho, Portugal.	A rather violent shock	....	A part of the mountain of Lames d'Orillon fell on this occasion, and a chasm of 80 palms in circumference opened at Meula in Murcia. v. Hoff, quoting Cotte, gives the date 17th August.	Gazette de France, 28 Sept. et 6 Nov.
—— —— 18.	Around Vesuvius	Some slight shocks...	....	Accompanying an eruption of the volcano. Both Etna and Vesuvius became active about the middle of June, and on this day the disturbance was most considerable at Etna.	Gazette de France, 24 Août; Éphém. de Mannheim, *loc. cit.*
—— —— 21.	St. Pierre in Martinique	A single shock.........	....	....	Cotte.
—— —— 26. About $8^h\ 15^m$ A.M.	Ferrara again	A violent shock	....	Accompanied by a loud noise. Some houses were thrown down.	Gazette de France, 7 Sept.; Éphém. de Mannheim, *loc. cit.*
—— Aug. 4.	In the country near Ferrara.	Some shocks as severe as the last.	....	During a terrible storm	Gazette de France, 14 Sept.; Éphém. de Mannheim, *loc. cit.*
—— —— 14.	Terni again	A slight shock	....	....	Éphém. de Mannheim, *loc. cit.*
—— —— 26. 1 A.M.	Peissenberg...............	One shock	....	....	See authorities for following account.
—— —— 28. 45 (or, according to v. Hoff, 55) minutes after midnight of the 27th.	Stuttgard, Munich, Augsburg, Landshut, Innsbruck, Pappenheim, Ansbach, Empten, Dillingen, and Ratisbon. Also at Zurich and Bâle.	At Stuttgard 2 shocks, each of 7 or 8 seconds. They were not so severe here as in the basin of the Danube. At Innsbruck the direction was S.W. to N.E. At Munich and Ratisbon also two distinct shocks were felt. At Bâle but one shock was felt.	....	At Innsbruck a magnetic needle deviated 0° 12′ to the east. It rained continuously there the whole day. At Stuttgard a violent wind had been blowing, but the weather was calm at the moment of the shocks.	Hamb. Corresp. Nr. 145, u. Beil; Cotte; Éphém. de Mannheim, pp. 202, 257, 266; Merian; Gaz. de Fr. 18 et 25 Sept.
—— Sept. 4.	The city of Mexico......	An earthquake of two	....	Buildings fell	Cotte.

5 A.M.		coming from S.W.			
—— —— 25. $0^h\ 15^m$ A.M. and 2 P.M.	Rome	Scarcely perceptible shocks at these two hours.	....	The Hamb. Corresp. gives the date 26th Sept...	Éphém. de Mannheim, p. 224; Hamb. Corresp. Nr. 169.
—— Oct. *Before* the 1st and 21st.	Jamaica, especially at Kingston and Port-Royal.	Earthquakes are mentioned as occurring in Jamaica in letters of these dates.	....	At Kingston a bridge fell	Hamb. Corresp. 1788, Nr. 13 u. 14.
—— —— 23. 4 A.M.	Island of St. Thomas ...	An earthquake, consisting of three feeble shocks.	....	A severe storm arose during the following night	Ditto, 1788, Nr. 18.
—— —— 27. $2^h\ 20^m$ P.M.	Montego Bay in Jamaica	Lasted ten or twelve seconds. The earth undulated slightly for some time afterwards.	The vessels in the harbour were agitated.	Preceded by a rumbling noise and concussions like distant thunder.	Annual Register, vol. xxxi. p. 3.
—— ——	Sienna	An earthquake in the course of the month.	On the 11th of this month the lake of Lugano was so violently agitated that an earthquake was suspected though none was felt. But as there was a very violent wind at the time the correctness of the supposition seems at least very dubious. (Hamb. Corresp. 1787, Nr. 179.)	....	Pilla quotes Soldani.
—— Nov. 3 and 4. For hours see column 3.	In the district of the Main and Neckar, at Gräfenhausen in the Black Forest, Deckenheim, Heidelberg, Mannheim, Darmstadt, Frankfort and Hanau.	At Gräfenhausen seven shocks were felt from 8 P.M. on the 3rd to 8 A.M. on the 4th. At Heidelberg, Mannheim, and along the whole route to Darmstadt, Frankfort, and Ha-	....	At Deckenheim the motion was so violent that the bell on the Rathhaus sounded several times, and the ceiling of a room fell off.	Hamb. Corresp. 1787, Nr. 181 u. 183; Gazette de Leyde, No. 92; Cotte; Époque, 5 Août, 1846; Gaz. de Fr. 20 Nov.; Éphém. de Mannheim, 1787 (?), p. 12.

1.	2.	3.	4.	5.	6.
		nau, the motion was felt at 3 and 6 A.M. on the 4th. At the same hours two shocks were felt at Kleinumstadt, from E. to W. At Mannheim the direction of both wind and shocks was N.N.W. to S.S.E.			
1787. Nov. 30. After sunset.	Terni again	A slight vibration			Éphém. de Mannheim, 1787, p. 226.
—— Dec. Night between 1 and 2.	Padua	Slight shocks		Accompanied by subterranean noise. From the 15th to the 24th of this month Vesuvius and Etna were simultaneously in eruption.	Ditto, p. 145; Hamb. Corresp. 1788, Nr. 1, Beil.
—— —— 8.	Hall in the Tyrol	A slight earthquake			Hamb. Corresp. 1788, Nr. 4.
—— —— Night between 20 and 21.	Island of Zante	An undulatory shock, coming from the west.		The Hamb. Corresp. (1788, Nr. 41. Beil.) records an earthquake at Zante on the 20th of January, 1788. The date is in all probability a mistake, and the earthquake the same with that here reported.	Gazette de France, 11 Mars 1788; Cotte.
—— —— 26.	Poppi (or Pappi) in Tuscany, and the environs.	Two severe shocks		Some damage was done	Gazette de France, 1 Fév.; Merc. de Fr. 2 Fév. 1788; Cotte.
—— —— 30. At night.	Rimini	A rather violent shock.		Much damage done	Gazette de France, 8 Fév. 1788; Hamb. Corresp. 1788, Nr. 4; Cotte.
——	The Azores	A violent earthquake.	The ocean inundated the country, and several small islands rose from the bottom of the sea, but soon after disappeared again.		Eyriès, Nouv. Ann. des Voyages, t. xvii. Janv. 1823, p. 53.
——	Tabriz in Persia	An earthquake			Silliman's Journal, vol. xxxvii. p. 351.
1788. Mar. 2.	Geneva	Two slight shocks			L'Institut, 29 Sept. 1842; quoting a MS. Journal of G. Ant. Deluc.
—— —— 3.	Naples. Not felt at the foot of Vesuvius itself.	A slight shock		During the eruption of Vesuvius, which had continued almost constantly since the middle of June, 1787.	Gazette de France, 1 Juillet.

	way. The Hamb. Corresp. says in various parishes of this diocese.				
—— —— 30.	Bâle	A vibratory shock			Merian quotes d'Annone's and Huber's Meteorol. Registers.
—— —— 31.	Geneva	Ditto		On the 10th May a piece of land sank with a terrible noise at Sunkenzoff in Bavaria. No shock mentioned. (Cotte.)	Éphém. de Mannheim, p. 326.
—— June. Middle of the month.	Pionsat in Auvergne	Several shocks		On the 14th June the road from Bristow to Milton (in England) sank to the extent of 9 feet along a space of 30 wersts (?). Gaz. de Fr. 30 Juillet. No shock is mentioned.	Mercure de France, 2 Août.
—— July 8.	Isle of Man	A shock of earthquake	On the same day the sea suddenly receded at Dunbar.	On the 17th of July the medicinal spring at Munzingen in Baden rose to an extraordinary height, a phænomenon also observed there on the day of the great earthquake of Lisbon in 1755. No shock mentioned. (Hamb. Corresp. Nr. 127.)	Thomson's Annals of Philosophy, vol. viii. p. 367.
—— Aug. 2. 11ʰ 30ᵐ A.M.	Stavanger in Norway	A severe shock from S. to N.		The wind was very stormy both before and after the shock.	Gazette de France, 26 Sept.; Cotte.
—— —— 12.	In the forest of Hundrück, between the Rhine and Moselle.	A severe earthquake			Hamb. Corresp. Nr. 139.
—— Oct. 5. 10ʰ 45ᵐ P.M.	Rome, Albano, and the neighbourhood.	A slight vibration			Éphém. de Mannheim, p. 101.
—— —— 12.	Island of St. Lucia in the West Indies.	An earthquake		900 persons perished during this earthquake	Mémorial de Chronol. t. ii. p. 932.
—— —— 20. 10ʰ 30ᵐ P.M.	Tolmezzo in the Venetian territory.	A severe earthquake		Seven houses were thrown down, and thirteen others violently shaken. The "Montes Forojulienses" were shaken, and on the 11th (or 21st?), at 7 A.M., a slight shock was felt "in montibus Taurijanis." v. Hoff records the earthquake at Tolmezzo on the 10th, and says that forty houses were destroyed by it.	Gazette de France, 28 Nov.; Éphém. de Mannheim, p. 370; Cotte; Hamb. Corresp. Nr. 189, Beil.
—— —— 29. About 11 P.M.	Darmstadt	A severe shock from S. to N.			Gazette de France, 18 Nov.
—— Nov. 18. 2 A.M.	Lisbon and Cintra. Also slightly felt at Quelus.	Some slight vibrations at Lisbon; stronger at Cintra.		Accompanied at Cintra by subterranean noise	Hamb. Corresp. Nr. 206; Gaz. de Fr. 19 Déc.

1.	2.	3.	4.	5.	6.
1788. Nov 22. Between 11½ A.M. and noon.	Ofen (Buda) and Esseck in Hungary.	Several vibratory shocks.			Gazette de France, 19 Déc.; Merc. de Fr. 20 Déc.; Hamb. Corresp. Nr. 199.
—— Dec. 18.	Aarhuus in Norway	A vibratory shock		Keilhau places this event on the 8th	Cotte.
—— —— 23. 2 A.M. and a little before 7 P.M.	Mayence, Frankfort, and the neighbourhood.	Two shocks at the hours mentioned respectively.		The day after snow fell, and a thaw began, but on the 26th the wind returned to the north, and the cold set in again with much severity.	Gazette de France, 20 Janv. 1789; Cotte.
—— At the end of this year, or beginning of the following one.	Carlowitz in Hungary	An earthquake		Houses were thrown down	Hamb. Corresp. 1789, Nr. 14.
1789. Jan. 18. 3 P.M.	Mayence, Frankfort, Epstein and Solms-Laubach; and more feebly at other places, as Cologne, Giessen, and Erfurt.	Several shocks			Gazette de France, 10 Fév.; Hamb. Corresp. Nr. 15, Beil, u. 17; Cotte; v. Hoff.
—— —— 20. A little before noon.	Mayence	Another shock			Ditto.
—— Feb 7. $5^h\ 35^m$ P.M. 6 P.M. in Calabria.	Messina, and in Calabria Ultra, especially at Monte-Leone and Reggio.	At Messina 2 shocks, the first very severe. They were undulatory, and from E. to W. In Calabria Ultra three were felt.			Gazette de France, 10 Avril; Hamb. Corresp. Nr. 42; Cotte.
—— —— 27.	Presburg in Hungary	An earthquake			Hamb. Corresp. Nr. 41.
—— Mar. 31.	At Venice, Friaul, and the places around.	Ditto			Ditto, Nr. 62.
—— May 5. 3¼ A.M.	Barnstaple in Devonshire.	An earthquake shock from E. to W., lasting one minute.		Accompanied by a rumbling noise	Gentleman's Magazine, vol. lix. p. 437.
—— —— 17.	Plauen on the Havel in Saxony.	Two vibratory shocks		Some floors were cracked	Gazette de France, 30 Juin; Cotte.

4h 30m A.M.		Up to the 15th the earth was scarcely five minutes at rest.		damage done. The earth opened in clefts, in some places 6 feet wide. New hot springs made their appearance near Reikum, between the rivers Thorsaa and Huitaa. The level of the surface was in many places altered, particularly around the lake Thingvallevate, which became dry in places where formerly it was 12 feet deep, and on the contrary, on its eastern side, spread itself over its former shore.	Abrégé des Voyages, t. vii. p. 183; Hamb. Corresp. Nr. 162; Voyage en Islande; v. Hoff.
—— —— — 9 A.M.	Barèges in the Pyrenees	One shock	....	Preceded by a low rumbling noise	Palassou, *loc. cit.* p. 269.
—— —— 13. 8h 58m P.M.	Mannheim	Two pretty severe shocks from N.E. to S.W., rapidly succeeding each other.	....	No damage done....................................	Gazette de France, 3 Juillet; Hamb. Corresp. Nr. 101; Cotte.
—— —— 16. Between 11 and 12 (A.M. or P.M.?).	Mannheim and Oggersheim.	A vibratory shock ...	....	....	Hamb. Corresp. Nr. 105, Beil.
—— —— 17. 9¾ A.M.	Barèges in the Pyrenees again.	Another shock.........	....	Accompanied by subterranean explosive noises...	Palassou, *loc. cit.*
—— July 27. 15 minutes past noon.	Adorf in the Voigtland..	Three shocks at intervals of five minutes. The first, the most severe, lasted one minute. Direction = N.W. to S.E.	....	Succeeded by light rain, the sky being covered with thick clouds. v. Hoff gives the date 23rd or 28th July.	Gazette de France, 28 Août; Hamb. Corresp. Nr. 125, Beil; Cotte.
—— Aug. 4 and 5.	Padua	Violent vibrations ...	....	....	Hamb. Corresp. Nr. 137.
—— —— 26. 9h 30m A.M.	Plauen in the Voigtland	A severe shock from E. to W.	....	The sky was clear, and the atmosphere suffocatingly hot.	Gazette de France, 6 Oct.; Cotte.
—— —— —	Pekin in China	An earthquake	....	....	Cotte.
—— —— Night between 27 and 28.	Lisbon	A severe oscillation...	....	....	Hamb. Corresp. Nr. 161.
—— Sept. 2.	Comrie in Perthshire ...	Two shocks on this day.	....	....	Edinburgh Trans. vol. iii. p. 240.
—— —— 26. At night.	Wenlock in Shropshire..	....	....	....	Gentleman's Magazine, vol. lix. p. 947.

1.	2.	3.	4.	5.	6.
1789. Sept. 30. 11^h 30^m A.M.	In Tuscany, the States of the Church, at Borgo-S.-Sepolcro, Castello, and Florence.	At Borgo-San-Sepolcro a violent shock, lasting two minutes. It was feebler at Florence, but again severe at Castello.	......	The earth opened near Borgo-San-Sepolcro, and houses with men and cattle were swallowed up. The little town of Sorei, lying between Castello and Florence, was completely ruined.	Hamb. Corresp. Nr. 167; Cotte; Gaz. de Fr. 3 et 27 Nov.
—— ——	Edinburgh	One shock	......	......	Cotte.
—— Oct. 28. About 6 A.M.	Berneck in the Black Forest. (According to v. Hoff, this should probably be in the Fichtelgebirge.)	Some earthquake shocks.	......	After a brilliant flash of lightning......	Berlinische Nachrichten von Staats, und Gelehrten Sachen, 1789, Nr. 138.
—— Nov. 5. 6^h 5^m P.M.	Cromarty and Crieff in Scotland.	A shock from S.E. to N.W.	......	Attended by a rumbling noise	Cotte; Thomson's Annals of Philosophy, vol. viii. p. 367.
—— —— 10.	Comrie in Perthshire ...	Repeated shocks	......	......	Edinburgh Trans. *loc. cit.*
—— —— 11. In the forenoon.	Ditto	Another shock	......	Accompanied by a hollow rumbling noise. A pond in the neighbourhood had the sheet of ice with which it was covered shattered to pieces. On the 13th of this month the mountain of Willach in Upper Carniola separated into two after several days' rain. No earthquake mentioned. (Gaz. de Fr. 1 Janv. 1790.)	Thomson's Annals of Philosophy, vol. viii. p. 367.
—— Dec. 24.	Calabria	......	......	The town of Novo-Castello and several villages were overwhelmed.	Mém. de Chronol. t. ii. p. 932.
—— —— 29.	Comrie in Perthshire ...	More shocks	......	......	Edinburgh Trans. *loc. cit.*
1790. Jan. 2. At noon.	Théis, in the mountains, four leagues from Grenoble.	A violent shock	......	......	Gazette de France, 26 Janv.
—— —— 10, 12 and 14.	Ancona	Shocks on these three days.	......	......	v. Hoff.
—— Feb. 27. 4 A.M.	Village of Armside in Westmoreland.	A violent shock	......	Accompanied by an explosion louder than thunder. At daybreak two clefts were found in the earth, one of which was very deep and 200 feet in length. Six houses and many cattle had sunk into it. The other chasm was smaller, and distant a league from the former. The motion of the sands lasted several hours. The Gazette de France places this event on the morning of the 21st.	Moniteur, 2 Avril; Hamb. Corresp. Nr. 43.

1790. Mar. 1.	Torres-Vedras in Portugal.	A rather violent shock, but of short duration.			Gazette de France, 27 Avril.
—— —— 5. 8 and 11 P.M.	Griesheim in Darmstadt	Two severe shocks at these hours.			Ditto, 2 Avril; Hamb. Corresp. Nr. 45.
—— —— 6. 4 A.M.	Ditto. Also felt at Darmstadt and in the Odenwald.	Another shock, of greater violence than the two former.			Ditto.
—— —— 13.	Breslau	A vibratory shock			v. Hoff.
—— —— 18.	Sta Maria di Niscemi near Terranova in Sicily.	Seven ditto. The sinking of the piece of land lasted until the end of the month.		Accompanying the gradual sinking of a piece of land of three Italian miles in circumference to the depth of 30 feet. From fissures in this spot, petroleum, sulphur, various vapours, hot water, and finally a stream of salt mud issued.	Ferrara, Campi Flegrei, p. 51; Huot, Géol. t. i. p. 113.
—— —— —	Malta			Several houses fell, and considerable atmospheric disturbance was perceived. On the 31st of this month, at 8 A.M., the mountain Scylla fell into the sea, which was much agitated at the distance of two leagues. (Moniteur, 25 Avril; Gazette de France, 4 Mai; Cotte.)	Moniteur, 4 Juin.
—— April. 6. 9h 29m P.M.	The Bannat, all Transylvania, Volhynia, the Eukraine, as far as Constantinople, and the Crimea. The district shaken was comprehended by a line extending from Dubno in Volhynia (the most northern locality), towards the west to Brody and Lemberg in Galicia, more to the south, to Hermannstadt and Shuppaneck in the Bannat, and as far as Constantinople (the southern limit). To the east, from Dubno to Berdiczow, Kiew, Niemirow (in	A violent earthquake, the shocks lasting about five minutes, and being followed by some more during the night. At Bucharest they only lasted 11 to 14 seconds. The direction of the shocks was in general S. to N., except at Niemirow, where they seemed to follow the course of the Bug, which flows to the S. and W. of the town.		Accompanied by a noise like the discharge of a thousand muskets. The atmosphere was calm. At Roman, Jassy, Kaminieck, Bucharest, Oczakow and Zycomierz, more or less damage was done to buildings, &c.	Ditto. 16 Mai; Gaz. de Fr. 21 Mai; Hamb. Corresp. Nr. 67, Beil. Nr. 69 u. 84.

1.	2.	3.	4.	5.	6.
	Podolia), Tulcayn, Bender, Oczakow, Cherson, and throughout the Crimea (the most eastern region).				
1790. May ...	In the Val-di-Noto in Sicily.	An earthquake	....	Catemasctta was greatly injured, and Palomba, built upon a promontory of tufa, sank into the sea. An eruption is reported to have occurred at one spot.	Hamb. Corresp. Nr. 91, Beil.
—— June 10. 3 A.M.	Ancona	A violent shock	....	The Hamb. Corresp. records this earthquake on the 9th.	Gazette de France, 20 Juillet; Moniteur, 23 Juillet; Hamb. Corresp. Nr. 111, Beil.
—— —— 12, 8 (A.M. or P.M.?)	Ditto	Another similar shock	....	....	Ditto.
—— —— 14.	Ditto	Ditto; still more violent than the two former.	....	Almost at the same time with these shocks others were felt in the Calabrias, the first of which were followed by terrible storms with thunder. In all probability the shocks given by v. Hoff on the 10th, 12th and 14th of January are merely the same with these, and the earlier date erroneous.	Ditto.
—— July. ... Night between 3 and 4.	Constantinople	Two shocks	....	....	Hamb. Corresp. Nr. 136.
—— —— 4.	Bâle	A vibratory shock ...	....	....	Meteorol. Registers of d'Annone and Huber.
—— —— 26.	Pontremoli	A severe earthquake..	....	Many buildings were injured. Vesuvius was in a state of energetic eruption about this time, according to letters from Naples dated the 28th.	Hamb. Corresp. Nr. 135.
—— Sept. 21.	At the mouth of the river Caura where it flows into the Orinoco, in the province of Caraccas, S. America.	A violent earthquake.	....	A piece of forest land (resting on granite) between the villages of S. Pedro de Alcantara and S. Francisco de Aripao sank 80 or 100 ft., and produced a lake of 400 toises in diameter.	Humboldt, Relat. Hist. t. ii. p. 639; Huot, Géol. t. i. p. 112.
—— Oct. 8, 9 and 10.	On the south coast of Spain and north of Africa, especially the country about Oran;	Simultaneous shocks on the opposite coasts. At Oran twenty shocks were	At Carthagena the sea was so much agitated that the persons employed	At Oran great damage was done to the fortifications and city, and some lives were lost. At Santa Fe in Spain considerable destruction of property likewise ensued, several houses	Hamb. Corresp. Nr. 180, 182, 184; Cotte; Moniteur, 2 Nov. et 21 Déc.; Gaz. de Fr. 9 Nov.

	and on the Spanish coast at various points between Carthagena and Malaga; and in the interior as far as Santa Fe, west of Granada. Also at Malta.	counted during the three days, and the earth shook repeatedly up to the 25th. At Malta but one slight shock was felt.	on the wharfs were obliged to fly.	being thrown down.	
1790. Oct. 13.	Terni in the Romagna...	Another earthquake...	....	....	Hamb. Corresp. Nr. 181, Beil.
—— —— 28.	In Calabria Ultra	Numerous shocks ...	....	....	Ditto, Nr. 197.
——	Island of Tobago.........	Three earthquakes during this year.	....	....	Ditto, Nr. 183.
—— or 1791.	In the valley of Maurienne (department Mont Blanc).	Several shocks	....	....	Communication of Mr. Alexis Billiot to M. Perrey.
1791. Jan. 24. 8½ P.M.	Darmstadt	A slight shock, followed by another at 4 A.M. the following morning.	....	....	Hamb. Corresp. 1791, Nr. 22.
—— —— End of the month.	Aquila in Italy	Numerous vibratory shocks.	....	Some old houses were thrown down	Ditto, Nr. 32.
—— Feb. *Before* the 22nd.	Calabria and the Abruzzo.	Shocks were still felt during the month, according to letters from Naples of the date given.	On the 2nd of this month the tide in the Thames rose two hours before its regular time and lasted so nearly eight hours. The water rose 3 feet higher than usual, a phænomenon which had not been known to happen for thirty years before. No earthquake, however, is spoken of. (Hamb. Corresp. Nr. 27.)	A frightful storm had occurred at Catania, followed by earthquake shocks.	Ditto, Nr. 44.
—— Between March and July.	Constantinople	Several shocks	....	....	Edinburgh Encyclopædia, Article Chronology.

1.	2.	3.	4.	5.	6.
1791. April 4, 5 and 6.	Kamtschatka	An earthquake on these three days.	....	The volcano Klutschewskoi sent forth smoke only.	v. Hoff.
—— May 6.	Ditto	Another earthquake ..	....	....	Ditto.
—— —— 16. 8 P.M.	East Haddam, Conn., United States. Also felt strongly at Killingworth, about 20 miles distant.	Two shocks in quick succession, of which the first was the more violent. Followed soon after by a third, slighter than the former, and by nearly one hundred still feebler shocks during the night.	....	At Killingworth at the time of the shock the fish leaped out of the water in every direction The atmosphere was very clear and warm; and the moon almost full, and remarkably brilliant. Subterranean noises are constantly heard at East Haddam, whence its Indian name, Morehemodus, or the place of noises. After this shock, both noises and shocks became less frequent.	Silliman's Journal, vol. xxxix. p. 338.
10 P.M.	Philadelphia, United States. Also felt at various other places in the eastern States; particularly at New York.	A slight vibration ...	....	....	Hamb Corresp. Nr. 128; Moniteur, 23 Août.
—— —— 17. 11h 34m A.M.	Dijon	Two distinct shocks like explosions in the space of three seconds. A lamp appeared to oscillate from E. to W.	....	....	Lettre de Guyton Morveau à Lalande; Moniteur, 23 Mai; Gaz de Fr. 31 Mai.
—— —— —— At night.	East Haddam, Conn., again.	Six more shocks during the night.	....	The night very fine....................................	Silliman's Journal, *loc. cit.*
—— —— 18. 10 P.M.	From Boston to New York.	A severe shock, followed by a slighter one, the latter being only felt at Hartford. During the night twenty or thirty more were felt. At Middle Haddam the first shock was severe and from W. to E.	....	Some damage was done. In the morning clefts were observed in the ground, and it was found that stones of several tons weight had changed their places. Probably the date of the shock at Philadelphia should be 18th instead of 16th.	Ditto.

1791. May 21. 1 A.M.	Turin	An earthquake		The evening before a reddish halo had been observed surrounding the sun, which phænomenon was considered by many there as a sign of approaching earthquakes.	Hamb. Corresp. Nr. 96.
—— July 8. 3 A.M.	In the Pyrenees, particularly violent in the commune of S^ta^ Marie.	Violent shocks, but of short duration. At the village of Escot four oscillations were remarked, apparently in the direction W. to E.			Palassou, *loc. cit.* p. 269.
—— Aug. 15.	Tivoli and Frascati in the States of the Church.	Some shocks			Cotte.
—— —— 29. Between 4 and 5 P.M.	Pressburg in Hungary and the country around.	Several shocks		Accompanied by a terrible storm, which overthrew buildings, and did great damage in the forests.	Moniteur, 27 Sept.; Gaz. de Fr. 30 Sept.; Hamb. Corresp. Nr. 150.
—— —— --	Lyons in France	One shock			Cotte.
—— Sept. 2.	Comrie in Perthshire	A vibratory shock			Edinburgh Trans. vol. iii. p. 240.
—— —— 27. 9 P.M.	In the island of Jersey.	Two shocks		Accompanied by a subterranean noise like the rolling of carriages. The evening was fine and starlight, and the wind soft, from the east. For many weeks great heat and drought had prevailed.	Hamb. Corresp. Nr. 169.
—— Oct. 11.	Foligno, Spoleto, Tolentino, and other places in the States of the Church. And at Rome itself.	At the first-named places very violent shocks. At Rome but two slight ones.		At Foligno, Spoleto, &c. many houses were thrown down. At Rome no damage was done.	Ditto, Nr. 180 u. 181; Gaz. de Fr. 18 Nov.
—— —— 13.	In the province of Cabri (should probably read Island of Capri).	A violent earthquake.		Much damage done to houses, &c.	Hamb. Corresp. Nr. 184; Gaz. de Fr. *loc. cit.*
—— —— 14.	In the parts of the States of the Church shaken on the 11th.	About twenty shocks.			Hamb. Corresp. No. 180 u. 181; Gaz. de Fr. *loc. cit.*
—— —— 28.	In England	A shock			Cotte.
—— —— 29.	Oran in Africa	A severe earthquake.			Hamb. Corresp. Nr. 189.
—— —— During this month.	Sicily, Calabria, and Turkey.	Simultaneous shocks devastated these three countries.			Gaz. de Fr. *loc. cit.*; Mém. de Chronol. *loc. cit.*

1.	2.	3.	4.	5.	6.
1791. Nov. 27. 11h 20m P.M.	Lisbon	A rather severe earthquake, consisting of two shocks. The first was merely five or six vibrations succeeding one another so rapidly as to be scarcely distinguishable. The second and more violent shock was undulatory, and occurred about five minutes after the former.	....	The second shock was attended with a hissing noise like that of red-hot iron quenched in water, and ended with an explosion like the report of a cannon. The bells in one of the churches rang out loudly.	Annual Register, vol. xxxv. p. 3; Hamb. Corresp. 1792, Nr. 4.
—— Dec. 2.	Island of Zante	A violent shock followed by others up to the 18th.	The most violent agitation occurred in the strait between Zante and the Morea.	The first shock threw down many houses, amongst others that of the Austrian Consul-General. A storm of rain, thunder, and lightning raged at the same time.	Hamb. Corresp. 1792, Nr. 5, Beil.
—— —— In this month. (Day not given.)	St. Paul's Bay in the St. Lawrence (about sixty miles N.E. of Quebec), Canada.	Severe shocks	....	Walls were cracked, and stones fell from the houses.	Lyell's Geology (5th ed.), vol. ii. p. 208; Trans. of Roy. Geol. Soc. (London), 2nd Series, vol. v. p. 97 (note).
1792. Jan. Beginning of the month (*before* the 5th).	Beja in Alentejo, Portugal.	Several vibrations ...	....	Accompanied by subterranean noise	Hamb. Corresp. Nr. 8.
—— —— 22.	Island of Martinique ...	A rather violent earthquake.	....	....	Journal des Mines, Nr. 18, p. 58.
—— Feb. Beginning of the month.	In some regions in Norway.	Subterranean commotions.	....	Great cold on the 13th and 15th of this month. On the former day, at noon, much lightning and thunder.	Merc. de Fr. 31 Mars.
—— —— 25.	In Lincolnshire	Shocks in the direction S.W. to N.E.	....	....	Phil. Trans. 1792, p. 283; v. Moll, Annalen, Th. 2. S. 431.
—— Mar. 1. 8½ P.M.	In Bedford, Leicester, Lincoln, Nottingham, and other counties.	A rather severe earthquake, consisting of a tremulous motion,	....	In Brewster's Encyclopædia, *loc. cit.*, the date 2nd March is given.	Annual Register, vol. xxxv. p. 10; Brewster's Encycl. Article Chronology; Mém. de Chronol. t. ii.

	At the hour mentioned, at Stamford and Doncaster.	and lasting several seconds.			p. 932.
1792. Mar. 7.	In Algiers	An earthquake			Hamb. Corresp. Nr. 72.
—— —— 9.	Bâle	A vibratory shock			Meteor. Reg. of d'Annone and Dan. Huber.
—— —— During the month.	Etna	More violent shocks than had been felt here for several months, during which time the volcano had not ceased trembling and sending forth smoke.			Ferrara, Descrizione dell' Etna, p. 131.
—— April 3.	Palermo	One shock			Hoffmann in Poggendorff's Annalen, B. 24. S. 54.
—— May 10.	Messina	More than thirty shocks during the day; all of them, however, being slight.		No damage done	Spallanzani, Voy. dans les Deux Siciles, t. iv. p. 109.
—— —— 11.	Ditto	Very violent shocks, followed by innumerable others about Etna itself for a whole year.	On the 21st of this month the sea rose at Sandvort in Holland higher than had ever been known before, and then sank suddenly again, the whole taking place in a few seconds. No shock mentioned. (Hamb. Corresp. Nr. 84.)	Accompanying a most violent eruption of Etna, which continued with more or less energy until May 1793.	Ditto; Ferrara, Descrizione dell' Etna, p. 131–137.
—— Aug. 28. 1 A.M.	East Haddam, Conn., United States.	Three shocks		Subterranean noises were heard at 10 P.M. The weather was very fine. Perrey gives the date 24th October.	Silliman's Journal, vol. xxxix. p. 338.
—— Nov.	Sienna	Another earthquake	On the 10th December an unusually high tide at Hamburg (Hamb. Corresp. Nr. 198.)		Pilla quotes Soldani

1.	2.	3.	4.	5.	6.
1792.	Kiachta and Tröitsko, Savks.	An earthquake		Produced the greatest consternation among the inhabitants.	Férussac, Bull. des Sc. Nat. t. xxi. p. 60; Keferstein.
——	Comrie in Perthshire	Several shocks during the year.			Thomson's Annals of Philosophy, vol. viii. p. 367.
1793. Jan. 1.	Christiansand in Norway.	An earthquake		Keilhau marks the year with (?) query, as if not certain of that part of the date.	Keilhau, *loc. cit.*
—— —— 11. 8 A.M.	East Haddam again	Another vibration		Accompanied by noise. The weather warm and fine.	Silliman's Journal, vol. xxxix. p. 338.
—— Mar. 1. 10 P.M.	In the Japanese island of Kiou-Siou, particularly in the province of Simabava.	A frightful earthquake		The earth opened in chasms, masses of rock fell from the mountains, men could hardly remain standing, &c. Preceded in January and February by volcanic eruptions in Japan and the Kurili Islands, and followed on March 2 by an eruption of Tuxtla in Mexico which lasted until November (v. Hoff).	Titsing, Illustrations of Japan (translated from the Dutch by F. Shobert), London, 1822; Humboldt, Fragmens Asiatiques, t. i. p. 220.
—— April 1.	Around the volcano Illigigama in Japan.	An earthquake		Accompanying a violent eruption of this volcano, from which a vast stream of water burst forth, destroying 53,000 men (!).	Ditto.
—— —— 5. 10½ P.M.	Hermannstadt in Transylvania.	Two vibrations rapidly succeeding each other.			Hamb. Corresp. Nr. 69, Beil.
—— ——	St. Domingo	An earthquake		More than thirty houses were overthrown	Edinburgh Encyclopædia, Article Chronology; Moniteur, 12 Août.
—— June 9.	Lisbon	A slight earthquake			Hamb. Corresp. Nr. 118.
—— July 6. 6 A.M.	East Haddam again	Another vibration		Weather very warm. Rain and thunder after the shock.	Silliman's Journal, *loc. cit.*
—— —— 30.	At Irkutsk. Also felt by Laxmann at the distance of 120 wersts from that place. (In what direction?)	An earthquake			Nova Acta Acad. Imp. Petropol. vol. ii. p. 10.
—— Sept. 28. 4 P.M.	Salisbury and Shaftesbury.	An earthquake shock from S.W. to N.E., lasting two seconds.		Attended by a rumbling noise. The weather very calm, and what wind there was easterly.	Gentleman's Magazine, vol. lxiii. p. 950.
—— Nov. 29.	Lisbon	A severe shock of 42 secs. duration.		Followed by abundant rain	Moniteur, 10; Ventôse, an. 2.
—— Dec. 8. (N.S.) 8^h 10^m P.M.	Kieff in Russia	An earthquake			Nova Act. Acad. Imp. Petropol. vol. xv; Hist. p. 71.

		shock.			
—— —— 12.	In Hesse Darmstadt ...	A vibratory shock ...	....	Accompanied by a violent rattling noise	Ditto, 1793, Nr. 205, Beil.
——	Island of Timor	An earthquake	....	High buildings were thrown down at Coupang..	v. Hoff.
1794. Feb. 6, or 7. 1 P.M.	Vienna and in Styria. Near Vienna it was strongest in the parts lying next the Danube, and at Brünn. The central point of this earthquake, where it was most strongly felt, was Leoben.	Ditto. At Vienna it lasted eight seconds. At Leoben oscillations were felt on the 8th and 9th.	....	At Grätz buildings were thrown down, as also in the Mürzthal, where a subterranean noise like thunder was heard. At Leoben most damage was done.	Hamb. Corresp. Nr. 28, Beil, Nr. 31 u. 35.
—— March 7. 4 and 11 P.M.	At the city of Mexico...	Shocks at both these hours, the first oscillatory, the second a sort of heaving motion from beneath.	....		Sonneschmidt, Mineralog. Beschreib. der vorzügl. Bergw.-Reviere von Mexico, 1804, S. 323.
—— —— —	Palermo	One shock	....	....	Hoffmann in Poggendorff's Annalen, B. 24. S. 54.
—— —— 9. 2 P.M.	East Haddam, Connecticut.	Two shocks, followed by a third at 11 P.M.	....	The atmosphere was clear in the morning, hazy and damp in the afternoon.	Silliman's Journal, vol. xxxix. p. 339.
—— —— 14.	Casan	An earthquake		The town was ruined	Mém. de Chronol. t. ii. p. 932.
—— May 12.	Innspruck	One shock	....	....	Hamb. Corresp. Nr. 86, Beil.
—— June 12. 11½ P.M.	Naples, Caserta, throughout Campania, and at Benevento and Ariano in Apulia. Especially violent at the foot of Vesuvius.	A very violent earthquake, with wave-like oscillations from E. to W.	....	Followed on the night of the 13th by the most tremendous eruption of Vesuvius since those of 1779 and 1631. For details, vid. v. Hoff. The eruption proper lasted until the 22nd, and was followed by violent rains accompanied by lightning, until the 7th July.	Hamilton in Phil. Trans. 1795; Breislak and Winspeare, Memoria sull' eruzione del Vesuvio accaduto la sera del 15 Giugno, 1794; Napoli, 1794; Gilbert's Annalen, B. 4 u. 5; v. Moll, Jahrbücher, &c. B. 1. S. 322. B. 5; v. Buch, Beobach. auf Reisen, B. 2. S. 104; Moniteur, 4 et 15 Thermidor, 24 Messidor et 6 Fructidor, An. 2; Audot, Roy. de Naples, p. 69, &c. &c.
—— —— Night between 13 and 14.	All the country around Vesuvius.	Numerous violent shocks.	....	At Naples houses were thrown down. Torre-del-Greco was buried beneath the lava (according to v. Hoff, on the night of the 15th).	Ditto.

1.	2.	3.	4.	5.	6.
1794. June 15. 9, 10 and 11 P.M.	All the country around Vesuvius.	Numerous violent shocks. The motion very irregular.	....	The eruption continued with the greatest violence, several new fissures opening, and lava streams issuing from them. About midnight the volcano became quieter.	Authorities quoted above (on the 12th).
—— —— 16. Some minutes past 11 A.M.	Buyuk Déré on the Bosphorus.	A slight shock........	....	The weather was calm; the sky a little clouded, and the heat rather intense.	Olivier, Voy. dans l'Empire Ottoman, t. i. p. 129.
—— —— Night between 17 and 18.	Vesuvius and all the country round.	A tremendous shock.	....	Accompanied by a noise like thunder. At the same time the greater part of the crater fell in, and the mountain thereby lost 454 Parisian feet of its height.	Authorities quoted above (on the 12th).
—— July 3.	In Turkey	An earthquake	....	....	Edinburgh Encyclopædia, Article Chronology.
—— Aug. 12.	Palermo	Ditto	....	....	Hoffmann, *loc. cit.*
—— Sept. 3.	Ditto	Ditto	....	....	Ditto.
—— Oct. 11.	Kingston in Jamaica, still more severe in the other parts of the island.	A violent shock	....	....	Moniteur, 29 Nivôse, An. 3.
—— —— 28. 5 A.M.	At Canea in the island of Candia	Moderate shocks, lasting some seconds.	....	It was calm at the moment of the shock, but soon after the wind began to blow from the west, and continued in that quarter for some days. Earthquakes are not uncommon at this place.	Olivier, *loc. cit.* t. ii. p. 298.
——	In Cumana, S. America.	An earthquake	....	....	Humboldt, Voyage (4to ed.) t. i. p. 307.
1795. Jan. 2. 2 A.M.	Comrie in Perthshire ...	An apparently perpendicular shock.	....	....	Gentleman's Magazine, vol. lxv. p. 74.
—— Apr. 29. Between 5 and 6 A.M.	Constantinople	Slight shocks	....	....	Moniteur, 1 Juillet.
—— Sept. 23.	At Ober-Cassel near Bonn.	A trembling shock ...	....	....	Kastner, Archiv für Physik, B. 3. S. 362.
—— Nov. 18. 11 P.M.	In England, extending from Leeds to Bristol and from Norwich to Liverpool.	Vibratory, from S.W. to N.E.	....	The wind had been S.W., and afterwards changed to N.W., followed by rain and suffocating heat. The motion of the earth was accompanied by a subterranean rolling noise. At Derby a fire ball, and at other places a luminous streak were observed in the heavens. The workmen	Phil. Trans. 1796, p. 353; Gilbert's Annalen, B. 4. S. 59; v. Moll's Annalen, B. 2. S. 431.

				fell from 30·28 in. to 28·8 in. between the morning of the 17th and the evening of the 28th. The Annual Register (vol. xxxviii. p. 64) gives the date 23rd November, a little before 11 P.M., for Birmingham and the country round; and the Bibliothèque Britannique (t. i. p. 124) reports it on the 28th Oct. at $11^h 5^m$ P.M., mentioning a number of places where it was felt.	
1795. Dec. Day not given. $2^h 10^m$ P.M.	Aleppo	Two shocks, the second being the more severe and rapidly succeeding the other. Apparent direction = N. to S.		Houses were cracked	Olivier, *loc. cit.* t. vi. p. 360.
——	In the province of Simabara, island of Kian-Siou, Japan.	An earthquake		55,000 men lost their lives on this occasion. Is not this merely a confusion of the two accounts of March 1 and April 1, 1793? They all, probably, refer to the same event. In this year a new volcanic island seems to have risen from the sea in the Aleutian group, off the coast of Kamtschatka. No shocks are mentioned at this time, though later such were felt in Unalaschka (v. Moll's Neue Jahrbücher, u.s.w. B. 2. S. 382).	Titsing, Illustrations of Japan.
1796. Jan. 10.	Lisbon	A severe shock			Hamb. Corresp. Nr. 41; Cotte.
—— —— 17.	Ditto	Another			Ditto; Mém. de Chronol. t. ii. p. 932.
—— —— 27. In the morning.	Ditto	Ditto, so violent that it was thought a second similar one would have destroyed the city. The earth shook up to the 21st February.		For some time storms had been experienced here, accompanied by extraordinary rains.	Hamb. Corresp. and Cotte, *loc. cit.*; Moniteur, 20 Germinal, An. 4.
—— Feb. Night between 4 and 5.	Florence, and more violently at Arezzo.	A rather severe shock, much more violent at Arezzo, where it was succeeded by others.		Chimnies and some buildings were destroyed	Moniteur, 15 et 17 Ventôse, An. 4; Cotte.

1.	2.	3.	4.	5.	6.
1796. Feb. A little before Mar. 6.	In Canada	A violent shock	....	Some of the rocks of the Falls of Niagara fell. The letter, dated Neward in Upper Canada, Mar. 6, says "lately" as to the date of this event.	Bibliot. Britann. t. ii. p. 86; Keferstein.
—— March 3 to 4.	Ulm	A vibratory shock ...	....	....	Hamb. Corresp. Nr. 46.
—— April 20.	Bâle..........................	Ditto	....	....	Meteor registers of d'Annone and Huber.
—— —— 26. Some minutes past 9 A.M.	In Asia Minor, especially at Latakiah (Laodicea).	A most destructive earthquake. The first shock, which was the most violent, and that which overthrew the houses, raised the surface of the ground several toises. The others were horizontal, and seemed to pass in the direction E. to W., i. e. from the land towards the sea. They lasted nearly a minute, diminishing in force from first to last. Two months after, slight tremblings and subterranean noises were perceptible.	The sea was perfectly calm.	The air was quite still, and the sun had a pale appearance before the shock. It was preceded by a subterranean noise, followed almost instantaneously by that of the falling houses. These latter fell so suddenly that even the people living on the street level were unable to reach the threshold in time to save themselves. The tobacco custom-house fell in, and the aga, his officers, and 400 workmen lost their lives in it. Altogether the third of the houses were thrown down, and the remainder more or less injured. Fifteen hundred persons perished.	Olivier, *loc. cit.* t. vi. p. 358; Cotte.
—— October. Night between 21 and 22.	Bienne in Switzerland...	Two severe shocks, lasting nearly a minute. Apparent direction = S. to N.	....	....	Moniteur, 25 Brumaire, An. 5.
—— —— 22.	In the territory of Modena.	A vibratory shock ...	....	....	Cotte.
—— —— 23. 6 A.M.	Ripon in England	An earthquake	....	A cleft opened in the ground, from which water issued.	Gentleman's Magazine, vol. lxvi. p. 873.

1796. Oct. Day not given. 2 P.M.	Manilla in the island of Luçon.	A violent earthquake, lasting altogether three minutes fourteen seconds. Several minor shocks were felt on the following days.	In vessels at anchor at Manilla the shock was not felt, but an English ship at sea, eleven leagues from that place, was greatly injured by it, her mainmast being driven up out of the step, by the blow from beneath.	During the shock the air was hot and close, and perfectly calm. Water was thrown out of the gutters and wells; so that a large cistern, which was full before the shock, was found to be diminished in depth to the extent of 3 inches. After the shock the narrator felt stupefied, and suffered pains in his knees.	De Guignes's account of the Philippine Islands, in Pinkerton's Voyages and Travels, vol. xi. p. 84.
——	Copiapo in Chili	An earthquake	....	....	Basil Hall, Journal written on the coast of Chili, vol. ii. p. 25.
1797. Feb. 4. 7¾ A.M.	In the territory of Quito, S. America. The centre of disturbance seems to have been the volcano Tunguragua; and the most violently shaken district extended forty leagues from S. to N. and twenty from W. to E. The earthquake was perceptible over a space of 170 leagues from S. to N. (from Puera to Popayan) by 140 from W. to E. (from the river Napo to the sea).	A terrible destructive earthquake. The first wave-like vibrations (at 7¾ A.M.) lasted nearly four minutes. At 10 A.M. and 4 P.M. more shocks were felt. They recurred at intervals up to the 5th April, on which day at 2¼ A.M. they were but little less violent than the first.	Flames and suffocating vapours burst forth from the lake of Quilotoa in the district of Llactacunga, and destroyed herds of cattle feeding on its shores.	Accompanied by loud subterranean noise. Similar noises had been heard from time to time in the interior of Tunguragua since 1791. Within the most violently disturbed district all the towns and villages were ruined, the houses being thrown down, and many crushed beneath great masses of detached rock. 40,000 persons perished. The ground about Tunguragua opened into enormous clefts, from which volumes of water and stinking mud issued, forming lakes in many places of considerable size. Tunguragua remained perfectly still during the earthquake, and the smoke of the volcano Pacto, seventy-five leagues distant, disappeared suddenly into the crater.	Annales de Historia Natural, t. i. Nr. 4, Madrid, 1800; Journal de Physique, t. xlix. p. 230; Gilbert's Annalen, B. 6. S. 67; Humboldt, Voyage (4to), t. i. p. 317; v. Moll's Annalen, B. 2. S. 435. &c. &c.
—— —— — About this time.	The Lesser Antilles ...	A series of shocks began at this time, which did not cease for eight months, until the eruption of the volcano in Guadaloupe on the 27th September put an end to them.	....	....	Ditto.

1.	2.	3.	4.	5.	6.
1797. Feb. 20.	Island of Sumatra, particularly in the district of Padang, and on the north coast to the extent of 2° latitude towards the south.	Lasted three minutes, followed by slighter shocks for three hours.	Terrible inundations were produced by the rising of the sea.	Also felt in some smaller islands, especially in Battoo. The volcano Merapi in Java was in eruption.	Gentleman's Magazine, vol. lxviii. p. 344; Phil. Trans. 1806, Pt. 2. p. 269; Froriep's Notizen, Nr. 570.
—— Mar. 8.	Palermo	An earthquake			Hoffmann in Poggendorff's Annalen, *loc. cit.*
—— July. Some time during the month.	Kingston in Jamaica	Some slight vibrations			Hamb. Corresp. Nr. 167.
—— Aug. 11 3 P.M.	Rivesaltes, Collioures and several other places in that region (depart. Eastern Pyrenees).	A shock of such severity that the cannon were shaken on their carriages.			Palasson, *loc. cit.* p. 269 and 270.
—— —— 13. 10¾ P.M.	Perpignan, more strongly at the village of La Roque, and most of all along the sea-coast from Collioures to Saint-Laurent-de-Salanque.	At Perpignan a vibratory shock lasting one minute. At Saint-Laurent-de-Salanque a shock had been felt before, at 9 A.M.		Perrey gives these shocks in 1798	Ditto.
—— Sept. 8.	In the village of Ille (depart. Eastern Pyrenees).	A heavy vibratory shock.			Ditto.
—— Oct. 19. 2 A.M.	Temeswar in Hungary	Vibrations during a quarter of an hour. This recurred at 3 and 5 P.M., and at 9½ P.M. two shocks were felt.		The two shocks at 9½ P.M. were preceded by a heavy rolling noise.	v. Moll's Annalen, B. 2. S. 442; Voigt's Magazin für des Neueste aus d. Phys. u. Naturgesch. B. 1. Nr. 2. S. 143.
—— Nov. 12.	Rouen	A vibratory shock			Cotte.
—— Dec. 14.	The town of Cumana, S. America, and the surrounding country.	A violent earthquake. Preceded by a slight wave-like motion. Then came violent perpendicular shocks from beneath up-		The town of Cumana was ruined, and terrible devastation produced in its neighbourhood. The state of the surface of the ground was changed in some places. Half an hour before the violent shocks a smell of sulphur was observed. On the bank of the Manzanares and	Humboldt, Voyage, t. ii. p. 275.

				ranean noise like bubbling, and then by the shocks. The latter were like the springing of a mine at a great depth, and laid four-fifths of the city in ruins.	
1798. Jan. 31.	Parthenay-le-Peuple, France.	A very feeble shock			Moniteur, 27 Pluviôse, An. 6.
—— Mar. 14. About 10 A.M.	Sarreguemines, Bliastel, and other communes of the department la Meurthe.	A very violent shock.		At Bitche a part of the arch of the bridge was raised. The district in which this shock was felt contains many mines of coal, of which one, like the Solfatara of Naples, is continually burning. Some days before, a meteor was observed three leagues from Metz.	Ditto, Germinal, An. 6.
—— —— Until July.	Messina	Repeated vibrations during this period.		Etna was in a state of eruption	v. Hoff.
—— May 26. 1h 15m A.M.	Florence and Sienna	At Florence a severe earthquake. The shocks lasted until daybreak, when the last and most severe occurred. At Sienna the motion was undulatory and as severe as at Florence.		At Florence many buildings were seriously injured. The shocks were preceded there by a loud explosion. It was remarked that they were less violent on the side towards the sea. For some days before the air had been very close and hot, but after the earthquake severe cold set in. On the 21st and 22nd a tremendous storm raged from Fiume in the Adriatic to Hungary.	Hamb. Corresp. Nr. 97, 99, u. 102; Moniteur, 30 Prarial, 1, 2, 3, 6, et 10 Messidor, An. 6.
—— —— Beginning of the following night.	Sienna	Another shock			Moniteur, *loc. cit.*
—— —— 27. Between 3 and 4 A.M.	Ditto	Ditto, equally violent. Others were felt on the 28th. Up to the 6th June twenty-two shocks had been felt, of which two were very violent.		At the end of the month the city was nothing but a mass of débris. A very deep chasm had formed in the principal square.	Ditto.
—— June 14.	Leghorn	A slight shock, followed in two hours by a stronger. Supposed direction = N. to S.			Moniteur, 21 Messidor, An. 6.

1.	2.	3.	4.	5.	6.
1798. June 17. At night.	Western part of the island of Teneriffe.	Some vibrations		Accompanied by loud explosive noises, heard over the whole island. Followed by a great eruption of Chahorra or Venge, a volcano close to, or rather on the side of the Peak of Teneriffe. This eruption lasted three months and six days. For details, vid. v. Hoff.	Bory de St. Vincent, Essai sur les iles Fortunées, p. 295; v. Buch, Canar Ins. S. 235, &c.
—— August. Beginning of the month?	From Perm in Russia to the Ourals, over a space of 500 wersts in length by 150 in breadth.	Several shocks from S.W. to N.E.		Preceded by subterranean noise	Nova Acta Acad. Imp. Petropol. vol. xiv.; Hist. p. 44.
—— Nov. 7. Between 1 and 1½ A.M.	Bordeaux and the country round.	"Commotions *assez semblables* à un tremblement de terre."		In the country some new walls fell	Moniteur, 27 Brumaire, An. 7; Hamb. Corresp. Nr. 189.
—— —— 15.	Semlin	Some slight shocks			Hamb. Corresp. Nr. 195.
—— Dec. Beginning of the month?	Calabria	Another earthquake	On the 17th December the sea rapidly rose above its usual level and extended 5 kilomètres as far as Aigues-Mortes (France). (Moniteur, 10 et 12 Nivôse, An. 7.) No shock is mentioned, but Perrey considers it as an instance of a "terre moto di mare."	This notice was written from Frankfort on the Maine on the 15th December, and merely said that Calabria had again suffered from an earthquake.	Ditto, Nr. 203; Beil.
——	Between the rivers Guaviare and Rio-Negro in the north of South America.	An earthquake			v. Hoff.
——	In Guatemala	A violent and destructive earthquake.	Some time in this year there was remarked a violent and unusual motion of the sea on the English coasts. No shock	In April there was an eruption of the volcano Isalco in Guatemala. (v. Buch.)	Ennery et Hirth, Dict. de Géogr. t. iv. p. 508.

			sac, Bull. des Sc. math. &c. t. iii. p. 176.)		
1799. Jan. Night between 7 and 8.	In Iceland	An earthquake	The sea inundated the country.	Accompanied by a terrible storm	Moniteur, 29 Prairial et 1 Messidor, An. 7.
—— —— 17.	Comrie in Perthshire	A shock from W. to E. of 2 secs. duration.		Accompanied by a subterranean noise	Thomson's Annals of Philosophy, vol. viii. p. 367.
—— —— 25. About 4 A.M.	On the west coast of France; at Rouen, Auxerre, Nantes, in La Vendée, at Rochelle, island of Oléron, Rochefort, Bordeaux, Laval, Caen, &c., and in Jersey. Also, according to some, in Paris itself.	At Caen (before 4 A.M.) some shocks, apparently from N. to S. At Laval ($3^h\ 45^m$) a pretty smart vibration. At Nantes (about 4) a severe shock, lasting more than a minute. At La Flèche ($4^h\ 15^m$) a shock of 25 secs. At Bordeaux a shock from W. to E., lasting more than a minute. At Machecoul several other shocks were felt during the day, the most severe being at 9 A.M. At the islands of Bouin and Oléron two shocks from S.W. to N E.		At Nantes and the island of Bouin (La Vendée) loud noise was heard. At Machecoul it rained soon after the shocks, and thundered all day. At the island of Bouin many houses were thrown down. The atmosphere appeared fiery-red, and soon after the earthquake a violent wind arose, which lasted two days. v. Hoff records another earthquake in the same region on the 26th January, 1800, but from the particulars given that date is obviously erroneous, and the account refers to the earthquake here given.	Journ. de Phys. t. xlviii. p. 181; Moniteur, 11, 14, 17 et 19 Pluviôse, 4 et 13 Ventôse, An. 7; Hamb. Corresp. 1799, Nrs. 25, 30, u. 35; Cotte, &c.
—— Feb. 5. Noon.	Nantes	Another very slight shock.		Accompanied by noise, without undulation, like a prolonged bellowing, or the rolling of a carriage.	Moniteur, 27 Pluviôse, An. 7; Hamb. Corresp. Nr. 33.
—— —— 6. $2^h\ 10^m$ P.M.	Ditto	Another shock, rather more perceptible than the last.		Accompanied by the same noise as before, but a little louder.	Ditto.
—— —— 19. 4 P.M.	Avignon	Two violent shocks		An old bridge and some houses were thrown down.	Moniteur, 13 Ventôse, An. 7; Cotte.

1.	2.	3.	4.	5.	6.
1799. Feb. Night between 21 and 22.	Frankfort on the Maine and Giessen. Also *supposed* to have been felt at Dusseldorf.	Earthquake shocks		Accompanied by a terrible storm, with lightning, &c.	Moniteur, 27 Ventôse, An.7; Hamb. Corresp. Nr. 37 u 46.
—— —— 24.	Comrie in Perthshire	A shock from W. to E., lasting 2 seconds.		Attended with subterranean noise	Thomson's Annals of Philosophy, vol. viii. p. 367.
—— ——	Breslau	Vibratory shocks			v. Hoff.
—— March 5. 4h 30m A.M.	Nice	*Another* earthquake			Moniteur, 27 Ventôse, An.7; Hamb. Corresp. Nr. 50.
—— April 20. 6 P.M.	Drontheim in Norway	An earthquake			Hamb. Corresp. Nr. 78.
—— —— or in May.	Iceland	Ditto		Very probably at the same time with the Drontheim earthquake.	Ditto, Nr. 88.
—— May 29.	Brescia	A severe earthquake		Houses were thrown down	Ditto, Nr. 100.
—— June 17.	Acapulco	A destructive earthquake.			Ditto, Nr. 181; Moniteur, 11 Brumaire, An. 8.
—— Aug. 18.	Palermo	An earthquake			Hoffmann, *loc. cit.*
—— —— —	In the mountains of Caripe and Carapano, near Cumana, South America.	Eleven severe shocks.		v. Hoff gives the date 28th August	Humboldt, Voyage, t. iv. p. 18, et t. x. p. 333; v. Zach, Monath. Corresp. Th. 1. s. 395.
—— —— 25.	Cumana	A slight shock			Humboldt, *loc. cit.*
—— Sept. 5. 7 P.M.	In Ekaterinodar (Russia)	Two severe shocks, rapidly succeeding each other. (During the rising of the island in the Sea of Azov also, vibrations were felt this day throughout the Kouban.)	At sunrise on this day a new island rose from the Sea of Azov opposite Temruck (200 wersts to the west of Ekaterinodar). This island was full of fissures, and threw forth stones, mud, flames and smoke. The following year it no longer existed.		Pallas, Reise in d. südl. Statthaltersch. des Russ. Reichs, Th. 2. s. 316; Keferstein, Moniteur, 29 Floréal, An. 8; Dubois de Montpereux, Voy. autour du Caucase, t. v. p. 32.
—— —— 29, to the end of the year.	Albano was apparently the centre of these shocks, which extended to Rome, Ma-	Repeated vibrations during this period.			Constitutionnel, 14 Juin, 1829; Preuss Staatszeitung, 1829, Nr. 170.

	sano.				
1799. Oct. About the middle of the month.	Lisbon	Two slight vibratory shocks.			Hamb. Corresp. Nr. 181.
—— ——	Hirschberg in Silesia	A vibratory shock			Berliner Spenersche Zeitung, 1837, Nr. 73.
—— Nov. 4. 4h 12m P.M.	Cumana, S. America	Two shocks, followed by a third, much feebler, at 9 P.M. The first two were in the (there uncommon) direction N. to S., and there was an interval of 15 seconds between them.		There had been an eclipse of the sun on the 28th October, and from that day until the 7th November the atmosphere was filled with a dry reddish vapour. A little before the shock, some people who were drawing water from a well of 18 or 20 feet deep, heard a noise like an explosion of gunpowder, coming, as it were, from the bottom. At the same time thunder and lightning were observed, and some minutes before the shocks a heavy gust of wind, followed by large drops of rain charged with electricity. These phænomena were succeeded by a calm, which lasted all the remainder of the night. The third shock was also accompanied by loud subterranean noise. The barometer was not affected, but Humboldt observed very remarkable changes in the variation of the magnetic needle.	Moniteur, 4 Floréal, An. 9; Humboldt, Voyage (8vo), t. iv. p. 16; Keferstein.
—— Dec. 11. In the afternoon.	In Silesia; at Schweidnitz, Glatz, Fredersdorf, Dittersdorf, Friedland, Liebwerda, Wittichsthale, Haindorf, Raspenau, Hirschberg, all the villages of the Riesengebirge, Schmiedeberg, Landeshut, &c., for the most part in a line from Glatz to Marklissa.	At Schweidnitz there was an oscillation of the surface consisting of three successive movements, quickly following each other. At all the other places the shocks were felt more or less violently, for the most part in the direction S. to N.		There was a thick fog at the time, which at one place smelled of sulphur. In almost all the places mentioned the shocks were accompanied by a subterranean rolling noise, which was also heard at many places where no motion was felt. In the coal pits between Glatz and Bohemia the shocks were strongly felt. At one place thunder and lightning, apparently coming out of the thick mist, preceded the earthquake, and the barometer oscillated considerably. Cats appeared uneasy before the shock. No similar event had occurred in this part of Silesia for fourteen years.	Voigt's Magazin, Th. 2. s. 263; Gilbert's Annalen, B. 4. s. 128, u. B. 5. s. 203; Neue Schriften der naturforschenden Freunde zu Berlin, B. 3. s. 180, 191 u. 199, &c.
—— At the end of the year.	In the Calabrias and at Messina.	Violent earthquakes			Moniteur, 8 Pluviôse, An. 8.

1.	2.	3.	4.	5.	6.
1799. Some time during the latter half of the year.	Truxillo ("in Honduras, Venezuela, or Peru?").	A destructive earthquake.		Very probably this alludes to the Cumana earthquake of the 4th November.	Hamb. Corresp. 1800, Nr. 20, Beil.
1800. Jan. 12 & 22. (O.S.?)	In the mines of Koutomarsk, near Nertschinsk, in the Ourals.	Some shocks from S.W. to N.E.		Preceded each time by an explosion like that of a 6-pounder, the noise lasting about 2 secs.	Férussac, Bull. des Sc. Nat. t. viii. (Mai 1826) p. 21.
—— Feb. 26. 9 P.M.	Lisbon	One shock		Accompanied by heavy rain. Buildings were injured.	Hamb. Corresp. Nr. 52.
—— —— 27. 3 A.M.	Ditto	Ditto		An eruption of Etna began on this day which recurred at intervals until the middle of the year 1802.	Ditto; v. Hoff.
—— March 8. 9 A.M.	At Mexico	A violent earthquake. The motion was first for 4 mins. from E. to W., then for some time from N. to S., and finally in a circular direction.		Many buildings were injured, and finally the earth opened in clefts.	Annales de Historia natural (Madrid), t. ii. No. 5. p. 235.
—— —— 17. $10^h\ 18^m$ A.M.	Ditto, and at the same time at Cuernavaca.	Repeated, but slight vibrations.		The air was stormy, and a tempest blew from the south. Two days before, the barometer oscillated to a great extent.	Ditto.
—— ——	Philadelphia in the United States.	One shock			v. Hoff.
—— ——	On the banks of the Ganges.				Philosophical Transactions.
—— April 1.	Port-Rieux in Bretagne.	An earthquake			Hamb. Corresp. Nr. 64.
—— June 23.	Palermo	Ditto		A letter from London of the 17th July says that a chasm had opened in Breadon Hill, Worcestershire, and was daily enlarging. It was supposed to have been caused by a *late* earthquake there, but when this occurred is not said. Possibly that of the 18th November, 1795, is alluded to. (Allgemeine Zeitung, 1800, no. 212. s. 894.) In the neighbourhood of Nice the fall of a mountain is also recorded about the end of July, no earthquake, however, being mentioned. (Allgemeine Zeitung, no. 231. s. 970.)	Hoffmann, *loc. cit.*

1800. Sept. Night of 23–24. $0^h\,50^m$ A.M.	Genoa	A violent shock, lasting some seconds.			Hamb. Corresp. Nr. 166, Beil.
—— —— 26.	Constantinople	Several shocks			Mém. de Chronol. *loc. cit.*
—— Oct. 17. 5½ A.M.	At Eaux-Chaudes and some other places in the valley of Ossau, in the Pyrenees.	Two shocks in the space of 5 minutes.		A great mass of rock was detached, and rolled some distance.	Palassou, *loc. cit.* p. 270.
—— —— 18.	Ditto	Another shock		Preceded by a loud subterranean noise.	Ditto.
—— Nov. 3. 11 A.M.	Zurich	A slight shock.			Moniteur, 26 Brumaire, An. 9.
—— —— 9.	Brussels. Also, perhaps, in Brandenburg.	Two shocks at Brussels.		During a tremendous tempest, which, from 7 P.M. of the 9th to 1 or 2 A.M. of the 10th, raged over France, central Germany, the Channel, England, the Baltic, and as far north as Copenhagen.	Hamb. Corresp. Nrs. 183, 184, 185, 186 u. 189; Moniteur, 25 Brumaire, An. 9.
—— —— 29.	Philadelphia in the United States.	A severe shock			Hamb. Corresp. 1801, Nr. 15.
—— Dec. 25.	Newport, Hanover, Boston, Concord, and other places in the United States.	Ditto			Moniteur, 24 Ventôse, An. 9.
——	Inverness in Scotland...	An earthquake			Thomson's Annals of Philosophy, vol. viii. p. 367.
—— & 1801.	Châteauroux (depart. Indre) in France.	Several shocks felt at this place in the course of the 2 years.			France pittoresque, t. ii. p. 92.
1801. June. 1st or 2nd Monday in the month.	Chester and the neighbourhood (England).	Rather a smart shock.			Moniteur, 24 Prairial, An. 9.
—— July.	Eskilstuna in Södermannland, Sweden.	A violent earthquake.	One mountain near the sea was covered with dead fish.	Houses were thrown down, mountains overthrown, and great damage done.	Ditto, 27 Vendémiaire, An. 10 (quoting "la rubrique de Stockholm, 8 Août").
—— Sept. 7. 6 A.M.	Edinburgh, Glasgow, Perth, Callander, Crieff, Stirling, and over almost the whole of Scotland. The centre appeared to be at Comrie in Perthshire.	Several vibratory shocks from N. to S. at Edinburgh.		Unaccompanied by noise	Tilloch's Phil. Mag. vol. x. p. 368; Thomson's Annals of Phil. vol. viii. p. 367; Moniteur, 8 Vendémiaire, An. 10.

1.	2.	3.	4.	5.	6
1801. Sept. Night between 10 and 11.	Colmar and Neu-Breisach.	A severe vibratory shock from N. to S. at Neu-Breisach.			Hamb. Corresp. Nr. 151, Beil; Moniteur, 3^{me} jour. complémentaire, An. 9; Cotte.
—— Oct. Night between 3 and 4. At midnight, 3 A.M. & 4 A.M.	Semlin on the Danube. Not felt in the environs.	Three shocks at the hours given. The 1st was more violent than the 2nd, and the 3rd more so than either of the former. One of them lasted four minutes.		Followed by heavy wind and rain, which lasted several days.	Moniteur, 10 et 13 Brumaire, An. 10.
—— —— 8. 8^{h}52^{m}53^s A.M.	At Bologna. Also, about same time, at Cesena; and in a part of the Romagna.	At Bologna, 3 shocks from N.E. to S.W., the undulation of the 1st (which took place at the time mentioned) diminishing by degrees until the 2nd and 3rd were felt. The three lasted only half a minute.		The atmosphere was calm, the sky overcast, and the thermometer at 13°·75 R. One of the clocks of the observatory was stopped, thereby giving the time of the occurrence. Some bells sounded of themselves, and a few chimnies were thrown down.	Ditto, 5 et 6 Brumaire, An. 10. (from an account by Sig. Ciccolini, director of the observatory); v. Moll's Annalen, B. 2. s. 451.
—— —— End of the month.	Frascati, Monte-Pozzio, Albano, Riccia, Velletri, and the surrounding district.	One shock			Moniteur, 6 Frimaire, An. 10.
—— Nov. Night between 12 and 13.	Philadelphia, United States.	A vibratory shock			Hamb. Corresp. 1802, Nr. 25.
—— —— 14.	Palermo in Sicily	One shock			Hoffmann in Poggendorff's Annalen, B. 24. s. 54.
—— (Beginning of December?)	Laybach in Carniola. Also at Eger.	A violent earthquake.		At Eger part of the fortifications fell	Moniteur, 18 Nivôse, An. 10 (quoting "la rubrique de Vienne, 22 Déc.").
——	Maracaibo, Caraccas and Porto-Caballo in South America.	Several shocks			Humboldt, Voyage, t. v. p. 13; De Pons, Voyage à la Terre-Ferme, t. i. p. 125.
1802. Jan. 1. 6^{h}45^m or 7^{h}15^m A.M.	Strasburg	From N. to S.		Great and wide-spread inundations for a month before.	Moniteur, 20 Nivôse, An. 10; Hamb. Corresp. 1802, Nr. 9, Biel.

1802. Jan. 4. Between 7 and 8 A.M.	Laybach, Trieste, Fiume and Bukkari in Carinthia. Also in the Bannat, and in Turkey.	At Laybach, slight. At Trieste, very violent. Several violent shocks from N. to S. at Fiume and Bukkari, each lasting more than a min.	At Fiume and Bukkari the sea rose in masses upon the shore.	In Carinthia some little hills disappeared, and new elevations were formed. Preceded, the same night, at Trieste by a terrible storm of thunder, rain, hail and snow, and a frightful inundation of the sea.	Moniteur, 7, 10, 16, 25 Pluviôse, et 3 Ventôse, An. 10.
—— —— About same time with the last.	Seigneurie of Grobbing (in Austria?).	....	....	Caused the fall of several masses of rock and the sinking of the earth in some places. Followed by terrible rain; accompanied by thunder and lightning. Probably the same shock with that last recorded.	Ditto, 12 Pluviôse, An. 10 (sous la rubrique de Vienne, 17 Janv.).
—— —— 17. 9h 15m A.M.	Caumont in the depart. Calvados, Normandy.	An earthquake, lasting 4 or 5 secs.	....	....	Hamb. Corresp. 1802, Nr. 21.
—— —— —	Torre-la-Mata and Torrevieja in Spain.	Shocks which continued up to the 6th February.	....	Some houses were destroyed............	Ann. de Chim. et de Phys. t. xlv. p. 395.
—— —— 23. In the evening.	Strasburg	Vibratory	....	....	Hamb. Corresp. 1802, Nr. 21, Biel.
—— Feb. 2.	Falmouth in Antigua ...	A severe shock	....	....	Moniteur, 24 Germinal et 25 Floréal, An. 10.
—— ——	Guadaloupe	Vibratory shocks ...	....	Accompanied by the eruption of a volcano	v. Hoff.
—— Mar. 19.	Antigua, St. Christopher's, and other West Indian islands.	Shocks felt several times during Feb. and Mar., but most violent on this day.	Accompanied by great agitation of the sea.	v. Humboldt remarked smoke issuing from Antisana in the Andes during this month of March.	Hamb. Corresp. No. 79; Moniteur, *loc. cit.*
—— April 5.	Orvieto in the States of the Church.	Three shocks in an hour.	....	....	Hamb. Corresp. Nr. 73.
—— May 9. 10h 40m A.M.	Lodi, Crema, and the country around.	Lasted 3 seconds......	....	Very probably the same event with the following, the date being incorrectly reported.	Tilloch's Magazine, vol. xiii. p. 95.
—— —— 12. 10h 10m A.M. at Mantua; 10h 30m at Milan; 10h 35m at Parma; 11h in Switzerland.	In Northern Italy, especially at Crema, Sonzino, Tegengo, Orcinovi and Brescia. Also in Switzerland, at Berne, Zurich, Geneva and other places; and as far south as the Romagna.	At Mantua the shock was severe; as also at Milan, where it was undulatory from S. to N., lasting about 2 mins. At Parma, three shocks, undulatory, from W. to E., and after an interval of 5 secs. the motion recommenced.	....	Most violent from west to east along the southern slope of the Alps. At Crema, Sonzino, Tegengo and Orcinovi the most damage of buildings, &c. occurred. At Brescia 11 houses and 3 churches fell. At Parma the direction was given by the swinging of a suspended lamp, which deviated 8 inches from the vertical. At this place the sky was quite clear and free from clouds, the barometer perfectly steady at 28 in., and the thermometer standing at 18°·25. At Genoa the motion was accompanied by a noise like the roll-	Cotte; Hamb. Corresp. Nrs. 87, 89, 93 u. 96; Moniteur, 6, 9, 10, 15 Prairial; Journ. des Débats, 4, 5, 9, 10, 15, 17 Prairial, et 18 Messidor, An. 10.

1.	2.	3.	4.	5.	6.
		At Cremona the motion was violent, but at Venice it was not felt. It was but slight at Turin, in Piedmont, and as far as Roveredo. Near Bardi and at Crema the shocks frequently recurred for three weeks.		ing of carriages or a distant cannonade. Near Bardi openings appeared in the earth, from which much petroleum was procured. The castle of Marguin, situated on the shore of a small lake, sank down and was covered by the water. At Berne furniture was shaken in the rooms, particularly in those of the third storey. An old man and a young woman were thrown down, and the bell of the Maison de Ville sounded.	
1802. May 15. 7 A.M.	In the territory of Darmstadt.	A violent shock of 15 to 20 secs. duration.			Journal des Débats, 17 Prairial, An. 10.
—— July 7-8, or 11. 9h 53m A.M.	Strasburg	A violent shock			Ditto, 25 Messidor; Moniteur, 28 Messidor, An. 10; Cotte.
—— Aug. 7. 2 P.M.	Caylus in the depart. Lot, France.	Ditto, lasting about 2 minutes.		The same day a loud explosive noise was heard at Cahors and for 40 leagues round it ("précédé d'une flamme dirigée de l'ouest à l'est, par un vent du sud, pendant 4 ou 5 minutes").	Journ. des Débats, 30 Messidor et 2 Fructidor; Moniteur, 30 Messidor, An. 10; Cotte.
—— —— 15. A little before noon, at noon, and at 8 P.M.	Cumana, on the north coast of S. America.	Three shocks at the hours mentioned, the last of which was less violent than the other two, and the second the most severe of the three.	The waters of the Orinoco rose so high as to leave a large part of the bed of the river dry.	The ground moved like the waves of the sea. In one place a piece of ground of 100 feet long and 40 wide sank down, and a pool of water appeared in its stead. In another place the ground was raised. A boat on the Orinoco received such a shock that the rudder was broken.	v. Humboldt, Voyage, t. v. p. 5; Moniteur et Journ. des Débats, 3 Nivôse, An. 11; Allgemeine Zeitung, Nr. 354. s. 1432; Hamb. Corresp. Nr. 197; v. Moll's Annalen.
—— —— 17. About 8 A.M.	Ogenne, in the canton of Navarreux, Lauveterre, and other adjoining places on the northern slope of the western Pyrenees.	A slight vibratory shock.		At La Rochelle accompanied by subterranean noise. In all probability the same shock with that at Ogenne, &c.	Palassou, Mém. &c. p. 270; Journ. des Débats, 10 Fructidor, et Moniteur, 12 Fruct. An. 10.
8 P.M. (?)	And at La Rochelle.	Ditto.			
—— —— 18 and 19.	Berne in Switzerland	Several ditto			Hamb. Corresp. Nr. 143; Moniteur, 12 Fructidor, An. 10.
—— —— 23.	Richmond in Virginia	A terrible shock		Attended with noise like the rolling of a carriage on pavement.	Moniteur, 26 Vendémiaire, An. 11.

—— in Aug.?	Amboyna and other East Indian islands.	A very violent earthquake.	The sea rose high upon the coasts, and did very great mischief.	No date is given, but the account is taken from letters of the 25th August.	Hamb. Corresp. 1803, Nr. 4.
—— Sept. 1.	Naples	At Naples a slight vibration. In the neighbourhood of Capua the shock was more violent.		For two days before smoke had issued from Vesuvius. At Naples there had been no rain, except on a single day, since March; the sky had been constantly clear, and the heat very great, especially on the 8th and 21st August, when it was almost unbearable.	Moniteur, 26 vendémiaire, an 11; Hamb. Corresp. Nr. 162; Cotte.
—— —— 11. A few minutes after 7h 30m A.M.	Strasburg	A rather violent shock from S.W. to N.E.			Journ. des Débats, 30 fructidor, 2 et 3 complémentaire, an 10, 1 et 2 vendémiaire, an 11; Moniteur, 2 compl. an 10 et 3 vendém. an 11; Hamb. Corresp. Nr. 155.
—— —— 12. 6h 36m A.M.	Ditto	Another shock, followed, an hour afterwards, by one of greater severity.		Accompanied by a violent wind from the south. The shock felt in the houses like the fall of a great weight.	Ditto.
—— —— 13.	Ditto	Four more shocks, the first of which lasted more than a minute.			Ditto.
—— —— 15. 2 A.M.	Ditto	Rather slight			Ditto.
—— —— —— 7h 4m A.M.	Ditto	Violent motion		Attended with subterranean noise	Ditto.
—— —— —— A little before midnight.	Ditto	More shocks, all from N. to S.			Ditto.
—— —— 25.	Kingston in Jamaica	A slight shock			Moniteur, 9 frimaire, an 11; Hamb. Corresp. Nr. 194.
—— Oct. 1. Between 9 and 10 P.M.	Beauvais in France	Ditto		At the same time a globe of fire was observed, which moved from E. to W., and disappeared with a loud explosion, leaving behind a strong smell of sulphur, which remained a long time.	Journ. des Débats, 15 vendém. an 11.
—— —— 23. 7h 30m A.M.	Strasburg	Another shock			Ditto, 7 et 13 brum.; Moniteur, 11 brum. et 3 frim. an 11; Hamb. Corresp. Nr. 175, Beil.
—— —— 24.	Ditto	Another, rather violent.			Ditto.

1.	2.	3.	4.	5.	6.
1802. Oct. 26. At Bucharest the motion began at 12^h 50^m noon. At Kronstadt it was 20 min. earlier than elsewhere. At Semlin at 12^h 15^m. At Warsaw at 12^h 30^m. At Constantinople about noon.	Very widely extended. Most violent in a part of Transylvania, in Wallachia, and Moldavia. It was felt at Bucharest, to the S.W. at Krajowa and Widdin; to the S. at Rusczuck, Varna, Constantinople, and the island of Ithaca (but not anywhere in the space between this island and the last-named places, or on the coast of Italy); to the N.W. at Kronstadt, Hermannstadt, &c.; also at Semlin and Temeswar, at Lemberg, and Warsaw; and in Russia at Kieff, Aral, Kaluga, Tula, Moscow, and even St. Petersburg.	At Bucharest the motion was undulatory, and continued for two minutes and a half. At 4^h 30^m P.M. the same day, at 3 A.M. the following morning, and on the 28th, slight vibrations were again felt as they had been before on the 25th. The shock was very violent in and around Cronstadt, where the direction was from E. to W. In Warsaw hanging bodies swung gently from S. to N. At St. Petersburg the shock was very slight, and from S. to N.	....	Many buildings were greatly injured in Bucharest, amongst others the Nicolai-kirche and its celebrated tower. The earth opened, and greenish water came forth which diffused an odour of sulphur through the whole city. Nothing remarkable had been observed in the atmosphere. The sky was overcast, the wind gentle and rather cool. In Pera (Constantinople) some houses were injured. The castle of Hidwy near Cronstadt was destroyed. In Hermannstadt the churches were so shattered that the people scarcely dared to approach them. Several other places in this district suffered also. At Warsaw the sky was clear, the wind from the N.E., and the barometer stationary at 28 in. At Jassy and Czernowitz damage was done to buildings. On the right bank of the Oka the shock was very violent; on the left it was not felt at all. At Moscow the walls were cracked, windows were broken, and cellars fell in.	Seetzen's account in v. Zach's Monatl. Corresp. Bd. vii. p. 20; v. Moll's Annalen, Bd. ii. p. 453; Hamb. Corresp. 1803, Nr. 177, 183, 189, Beil; Moniteur, 6, 14, 17, 18, 20, 21, 24 frim. et 13 nivôse, an 11; Journ. des Débats, 14, 18, 19, 21, 23 frim. et 12 nivôse.
—— —— — 8¼ P.M.	Caermarthen in Wales ...	....	....	....	Gentleman's Magazine, vol. lxxii. p. 1154.
—— —— Night between 29 and 30.	Wienerisch Neustadt ...	Lasted six seconds ...	....	....	Hamb. Corresp. Nr. 197; Journ. des Débats, 30 frim. an 11.
—— Nov. 7. 11^h 45^m A.M.	At and around Algiers...	A violent shock in the vertical direction, lasting 40 seconds.	Felt on board ships fifty miles from land.	The greatest amount of damage was done at Blidah (south of Algiers) and its neighbourhood. A village of 200 houses was swallowed up.	Journ. des Débats, 20 frim.; Moniteur, 19 frim. an 11; v. Moll's Annalen, Bd. ii. S. 458.
—— —— —	In Transylvania and Wallachia.	Another severe earthquake.	....	....	Ditto.
—— —— — In the evening.	On the southern coast of Spain, and again at Algiers.	Several vibratory shocks.	The sea was slightly agitated.	The atmosphere was cloudy and warm............	Ditto.

ing.					
—— —— — 11^h 30^m P.M.	Strasburg. Said to have been, like all the former shocks, quite local. It was, however, felt at Weissemburg.	Another shock, the most violent of all those felt this year.	....	Produced cracks in some vaults	Journ. des Débats, 23, 24 brum. et 1 frim. an 11; Moniteur, 24 brum. et 3 frim.; Hamb. Corresp. Nr. 185.
—— —— 22.	Coire and several other places in the Grisons.	A rather severe shock	....	....	Journ. des Débats, 4 nivôse, an 11; Hamb. Corresp. Nr. 205, Beil.
—— —— 26. 1 P.M.	Constantinople, Galata, and Pera.	Violent vibrations for nearly two minutes.	The sea remained calm	The day was hot, and the wind from the north. Many houses were injured. Very probably only the event of October, incorrectly reported as to date.	v. Moll's Annalen, Bd. ii. S. 459.
—— —— 27. 1 (or 2) A.M.	Autun in the department Saône et Loire. Also at Arnay in the depart. Côte-d'Or.	Several shocks........	....	Preceded by a dull noise moving from E. to W.	Journ. des Débats, 10 et 19 frim.; Hamb. Corresp. Nr. 197.
—— Dec. 12.	In the district of Mont-Blanc.	Vibratory shocks......	....	....	Keferstein, Verzeichniss der Erdbeben, u.s.w. in Zeitung für Geognosie, Geologie, u.s.w. Weimar Jahrgang, 1827, St. iii. S. 326.
—— —— 18.	In Swabia. Also in the Netherlands, especially at Rotterdam.	Ditto	....	....	Ditto.
—— —— 18 to 23.	Sion in the Haut-Valais. Not felt in the Bas-Valais, even at St. Pierre but two leagues from Sion.	Frequent slight shocks. Recurred on the 25th and 26th.	....	Some of the shocks of October and November had also been felt in this district.	v. Moll's Annalen, *loc. cit.* S. 460.
—— —— 20.	Elbeuf in the depart. Seine-Inférieure.	A shock of eight seconds' duration.	....	A violent storm occurred on the same day	Journ. des Débats, 6 nivôse; Hamb. Corresp. 1803, Nr. 3.
—— —— Night between 23 and 24.	Mayence	A slight earthquake...	....	....	Hamb. Corresp. Nr. 2.
—— —— 31. 11 A.M.	Sisteron in the department Basses-Alpes.	A rather severe shock, which recurred at 2 P.M.	....	The air was calm, the sky overcast, and the wind south. The barometer had been much agitated during the morning. The sun rose of a glowing red colour.	Journ. des Débats, 19 nivôse; Hamb. Corresp. Nr. 11.

1.	2.	3.	4.	5.	6.
1802.	Unalaschka, one of the Aleutian islands.	Very violent shocks during the year.	....	....	Langsdorff's Bemerkungen auf einer Reise um die Wett. Bd. ii. p. 209; Gilbert's Annalen der Physik, Bd. xlii. S. 217 u. 414.
1803. Jan. 8. 1h 15m A.M.	Bialystock in Poland ...	A violent shock, followed, at 4 and 5 A.M., by others, all apparently coming from the west. In the following night, at 11¼ P.M., another shock was felt, and some inhabitants believed that there were still more afterwards.	....	The winter had been very mild, and in December but little snow had fallen. On the 2nd January, however, the temperature suddenly fell to −21 R., and yet two days afterwards a thaw set in. On the 6th the cold suddenly returned, and at the time of the first shock the thermometer stood at −25 R. By this shock buildings were shaken from their foundations. The next morning, in the city, a long and perfectly straight crack was observed in the frozen ground. Several other cracks were remarked on the morning after, and one in the wall of a strong public building. The cold became very great, and continued so for four days. During the whole period described there was very little wind, but on the evening of the last shock a pretty strong north wind blew, which, v. Hoff observes, extended widely over Europe, and appeared as a violent tempest at Trieste on the 11th.	v. Moll's Annalen, Bd. ii. p. 460; Journ. des Débats, 19 et 21 pluviôse; Moniteur, 23 pluviôse, an 11.
—— —— Last week of the month.	Sion in the Valais	Several shocks, more violent than those felt here in the preceding month.	....	....	Hamb. Corresp. Nr. 32, Beil; v. Moll's Annalen, *loc. cit.*
—— Feb. 2. Between 11 P.M. and midnight.	Marseilles	A rather violent shock	....	Some chimnies were thrown down. v. Hoff, quoting the Hamb. Corresp. and v. Moll, gives the date Feb. 3.	Journ. des Débats, 24 pluv. an 11; Hamb. Corresp. Nr. 32; v. Moll's Annalen, *loc. cit.* p. 461.
—— Mar. 12.	Guadeloupe	A severe earthquake	....	....	Hamb. Corresp. Nr. 108.
—— —— 17. 9h 15m P.M. to 15m past midnight.	Pointe-à-Pître, Santa-Anna, and Maria Galante.	Thirteen shocks in the time mentioned, the first at 9h 15m.	....	....	Eyriès, Histoire des Voyages, quoted by M. Perrey in his memoir on the earthquakes of the Antilles.
—— April 25.	At Niort, and in the depart. Deux-Sèvres.	A slight vibration ...	....	....	Journ. des Débats, 15 prair. an 11.

the beginning of the month.		not sufficiently violent to cause any damage.			
——— 24. 11 P.M. At Laurwig 11h 5m.	Christiana in Norway. Also felt at Laurwig.	A violent shock from E. to W.; at Laurwig it was slight, and from N. to S.		At Christiana the shock was preceded by a noise like thunder. At Laurwig it was *followed* by an aërial disturbance and noise. The electrometer did not indicate any considerable amount of electricity in the air.	Moniteur, 9 fructidor, an 11; Keilhau; Cotte.
——— ...	On the banks of the Ganges, especially in the upper part, from the Jumna to the mountains from which it springs.	A very violent earthquake.		The town of Barahat (Berahhat or Badrinath), amongst others, suffered greatly from this event. Several villages were swallowed up.	Asiatic Researches, vol. xi.; Neue Allg. Geogr. Ephem. B. viii. S. 157.
—— Aug. 15. Between midnight and 1 A.M.	Constantinople	Vibratory		On this same night there rose an island in the Claveezer See near Plön in Holstein. It was about a thousand yards from the nearest point of land, in three fathoms water, and had a circumference of about eighty feet, rising three or four feet above the surface of the water. The island consisted of the sand of the former bottom with fragments of turf. No earthquake is mentioned at the place. The island was gradually washed away and disappeared. (Gilbert's Annalen, B. xvi. S. 384; Voigt's Magazin, B. vi. S. 260. u. B. vii. S. 364, &c.)	Moniteur, 16 vendém.; Journ. des Débats, 17 vendém. an 12.
——— 16.	Riom in Auvergne	Several shocks			Cotte.
——— 19.	Constantinople	More shocks, apparently from N. to S.			Moniteur and Journ. des Débats, *loc. cit.*
——— 25.	In Spain and at several points on the coast of the Mediterranean.				Mém. de Chronol. t. ii. p. 932.
—— Oct. 8. Between 6 and 7 P.M.	Gordes in the depart. Vaucluse, France.	Some persons *believed* they felt an earthquake.		An aërolite fell at Apt on the same day between 10 and 11 A.M.	Moniteur, 2 frim. an 12.
——— 13 and 14.	Palermo	Several shocks			Poggendorff's Annalen, Bd. xxiv. S. 54.
——— 17. (O.S.)	Tiflis	An earthquake		Walls were cracked by the shock	Dubois de Montpéreux, Voy. autour du Caucase, t. iii. p. 271.

1.	2.	3.	4.	5.	6.
1803. Oct. 17.	S. Philippe and Beniganim in the kingdom of Valencia, Spain.	A rather violent vibration.	....	No damage ensued	Moniteur, 19 frim. an 12.
—— Nov. 9 and 10.	Palermo and Messina ...	Severe shocks, in the direction from E. to W.	....	Etna remained undisturbed	Poggendorff's Annalen, *loc. cit.*; Hamb. Corresp. 1803, Nr. 202; Journ. des Débats, 27 frim.; Moniteur, 28 frim. an 12.
—— Dec. 12. 4h 30m P.M.	Chamouni	Violent, and in the direction S. to N.	....	Mont Blanc was violently shaken, and a mass of ice of 100 feet in height fell from it. Soon after the mountains of Breven suffered the same concussions, and great masses of rock were detached and rolled into the valleys below.	v. Moll's Neue Jahrbücher d. Berg- u. Hüttenkunde, Bd. ii. S. 309.
—— —— 13.	Along the Lower Meuse, especially in Vlaardingen, Maasland, Rotterdam, and Schiedam.	An earthquake consisting of slight oscillations.	Also perceived on board ship by the unusual disturbance of the water.	....	Ditto; Hamb. Corresp. 1804, Nr. 13.
—— —— 28. At Antwerp at 7 A.M.	Nantes, and Antwerp ...	Some people at each of these places *believed* that they had felt a shock.	....	During a tremendous storm which raged also at Paris and Rouen. An igneous meteor was observed.	Journ. des Débats, 10 et 12 nivôse; Moniteur, 11 et 13 nivôse, an 12; Hamb. Corresp. *loc. cit.*
——	In the district of Kemaon at the foot of the Himalayas, and in the neighbouring provinces.	Very violent	....	Many buildings were ruined. Possibly the same with the event of July. In this year also there was a violent eruption of Wororai in Hawaii, Sandwich Isles.	Berliner Spanersche Zeitung, 1837, No. 59; Edinburgh Journal of Science, vol. vi. p. 371.
1804. Jan. 13. Between 5 and 6 P.M.	Madrid and Aranjuez. Also felt at the same time at Malaga.	At Malaga a violent vibration from N. to S., lasting 55 secs.; more violent at Aranjuez than at Madrid.	....	....	Hamb. Corresp. Nrs. 22 u. 25; Journ. des Débats, 15 et 29 pluviôse; Moniteur, 30 pluviôse, an 12.
—— —— —— During evening service.	Rotterdam and the neighbourhood; and at the Hague and Bois-le Duc.	A shock which was violent at the Hague and Bois-le-Duc.	Felt also at sea	....	Journ. des Débats, 1 pluviôse; Moniteur, 3 et 5 pluviôse, an 12.
—— —— Night of 20–21. Mid-	Malaga. Also very destructive at Velez, five miles from Malaga,	Several shocks. That at 5 A.M. was very violent, in the direc-	....	Accompanied at 5 A.M. (4h 55m according to v. Hoff) by noise. The atmosphere was obscured and hot.	Journ. des Débats, 13 ventôse; Moniteur, 14 ventôse, an 12; Hamb. Corresp. Nr. 33.

night, 3 and 5 A.M.	and in Murcia.	tion N. to E. (sic), and the motion lasted nearly a minute.			
1804. Jan. End of the month.	Rotterdam, Haarlem, &c.	W. to E.		In one of the churches the chandeliers swung more than two feet from the perpendicular.	Gentleman's Magazine, vol. lxxiv. p. 267.
—— Feb. 3. 1 A.M.	Departm. Mont Blanc	Shocks			Voigt's Magazin, Bd. viii. p. 72.
—— —— 6. 1 A.M.	Motril in the kingdom of Grenada.	The shocks continued from the time of those at Malaga up to this date, one or two being felt each day. That of the 6th here given was the most violent. Its direction was supposed to be W. to E. The shocks recurred at intervals of (within a few minutes) three hours, and always lasted four minutes.	These shocks extended to sea.		Moniteur, 23 ventôse; Journ. des Débats, 24 ventôse.
—— —— 9.	Palermo; and, the same day, near Mt. Etna.	At Palermo one shock. At Etna a *perceptible* vibration.			Ann. de Chim. et de Phys. t. xxi. p. 400; Poggendorff's Annalen, *loc. cit.*
—— —— 15.	St. Petersburg	Vibratory			v. Hoff.
—— —— 16. A little after 6 A.M.	Motril in Grenada. Also this day at Malaga.	A rather severe shock, lasting 2 or 3 secs. At both Motril and Malaga numerous shocks during the day.			Moniteur, 23 ventôse; v. Hoff.
—— ——	In Styria	Shocks		On the 24th of this month a great storm of thunder and lightning raged over nearly all Germany, the whole of the Netherlands, and even as far as Moscow, accompanied by snow, and did much damage to buildings in various places.	v. Hoff; Hamb. Corresp. Nr. 37 u. 65.

1.	2.	3.	4.	5.	6.
1804. Feb.	St. Servan in France ...	Shocks........	....	....	v. Hoff.
—— Mar. 1.	Malaga, and Motril in Grenada.	Repeated shocks	....	....	Ditto.
—— —— 2. 2 A.M.	Moustier in the departm. Mont Blanc.	Several shocks........		....	Journ. des Débats, 28 ventôse.
—— —— Night between 3 and 4.	La Flotte in the departm. Charente-Inférieure.	A slight shock from S.E. to N.W.	....	Accompanied by a rather loud subterranean noise. The Journ. des Débats adds that shocks had been felt in the Alps, and in different parts of Europe and *Africa*. Perhaps some of the shocks reported at Malaga extended to the opposite continent. The Hamb. Corresp. gives the date of the event at La Flotte March 5–6.	Ditto; Hamb. Corresp. Nr. 50.
—— May 5.	Malta	One shock	....	....	Hamb. Corresp. Nr. 157.
—— —— 11.	Florence	Ditto	....	....	Journ. des Débats, 23 prairial; v. Hoff.
—— —— 13.	Ditto	Ditto	....	....	Ditto.
—— —— 17.	Ditto	Ditto	....	....	Ditto.
—— —— 18.	Virginia and New York	Vibratory shocks......	....	....	v. Hoff.
—— —— 26.	Malta	Another shock	....	....	Hamb. Corresp. Nr. 157.
—— June 8. Soon after midnight of the 7th.	S^{ta} Maura, Zante, in the Morea, at Patras. Most violent at Patras.	Two very severe shocks, followed by a third at 3 A.M. The duration of the first two was 30 to 40 seconds. The third was less violent and did not last so long. On the two following days slight oscillations of 6 to 10 seconds were felt.	The ships in the harbour of Patras were violently agitated.	The third shock overthrew many houses in the Morea, especially at Patras. It is said that shocks were common this year in the two islands in question, more than 100 having been felt in 1½ year, of which, however, but four or five were violent; and that one had been felt here thirteen years before. Preceded, on the present occasion, by a perfect calm, great heat, and a terrible noise lasting two seconds.	Journ. des Débats, 10 thermidor; Moniteur, 11 thermidor; Hamb. Corresp. Nr. 121.
—— —— 13. $3^h 30^m$; $7^h 5^m$; and 7^h 50^m A.M.	Klagenfurth in Carinthia	Three shocks at the hours mentioned, the last being the most violent.	....	There had been a terrible storm two days before. The barometer was not disturbed.	Journ. des Débats, 21 messidor; Moniteur, 22 messidor.
—— —— 14.	Baudissin (Budissen in Silesia?) and several other points in Prussia.	Several shocks	....	There suddenly appeared on several of the mountains springs which had never been seen before. From the 15th to the 20th June the	Moniteur, 22 et 23 messidor.

				Elbe and neighbouring rivers inundated their banks, and *it was supposed* that an earthquake was felt at Dresden.	
1804. July 28.	Spoleto and as far as Nocera.	Violent shocks, especially the first ones. They recurred frequently up to the 26th August, and on the 25th September, the day of the eruption of Vesuvius, the earth in the vicinity of the crater trembled violently.	....	The air was full of thick fog, so that the moon appeared of a blood-red colour. Vesuvius sent forth smoke at the moment of the first shocks. Spoleto itself suffered less damage than many of the villages in the neighbourhood. The Hamb. Corresp. gives the date August 1. On the night of the 4th July a little hill on the peninsula of Taman in the Sea of Azof rose gradually to the extent of 12 fathoms, and finally an eruption took place, and masses of earth and stones, in a state of ignition, were thrown to a great distance.	Journ. des Débats, 14, 20, 23 fruct.; Moniteur, 15, 21, 28 fruct. an 12. et 3 brum. an 13; v. Hoff; Hamb. Corresp. Nrs. 137, 147, 181, Beil.
—— Aug. 7. (O.S.?)	Tiflis in Georgia	A slight shock.........	....	This date and those of the shocks in the following months are probably all recorded according to the *old style*.	Dubois de Montpéreux, Voyage autour du Caucase, t. iii. pp. 271–274.
—— —— Night between 11 and 12.	Ditto	Ditto	....	....	Ditto.
—— —— 16.	In Auvergne	Vibratory shocks......	....	....	v. Hoff.
—— —— 20.	Malaga and Madrid ...	Ditto	....	....	Cotte.
—— —— 22 to 25.	In the kingdom of Grenada, especially at Albugnol.	....	....	....	Moniteur, 24 fruct. an 12, 14 et 29 vendém. et 4 brum. an 13; Journ. des Débats, 11, 13, 21, 28 vendém. an 13.
—— —— 25. Beginning at $8^h\ 30^m$ A.M.	Almeria in Grenada, and the surrounding district. Also at Madrid, Malaga, and Carthagena. "The region shaken was parallel to the line of the Sierra-Nevada, and consequently to the axis of the Mediterranean basin."—v. Hoff.	Within three-quarters of an hour, three terrible shocks and many slighter ones were felt at Almeria. At Albugnol five very violent shocks. The direction was S. to N.	The Salinas of the Bay of Rochetta were submerged, and much salt destroyed. Near Albugnol the sea remained quite calm.	Commenced with a low subterranean noise. Houses fell or were much injured. Rochetta was for the most part ruined. Castel del Popolo, Bella Villa della Palma, and Euiz were also destroyed. In Dalias men were buried beneath the ruins, and in Feliz a bell fell from the church tower. At Albugnol the heavens were obscured by a dark mist, which resolved itself into a cloud, whence, in ten minutes, five terrible flashes of fire (lightning?) issued, and after each flash a shock took place. A strong wind dispersed the clouds, and intense heat set in, which lasted until the 28th, as did also the shock. A mountain in the neighbourhood	Ditto; Hamb. Corresp. Nrs. 144, 157, 169; v. Moll's Annalen, Bd. v. S. 326.

1.	2.	3.	4.	5.	6.
				was cleft, and from the opening a stream of water poured out upon the lower parts of the town. Springs disappeared in some places, and new ones burst forth in others. Rivers were dammed up and changed their course.	
1804. Aug. 25. 10 A.M. and 12 noon.	In the Netherlands; at Schiedam at the hours mentioned.	....	....	....	Ditto.
—— —— —	Clermont Ferrand in Auvergne.	....	....	....	Tilloch's Philosophical Magazine, vol. xx. p. 184.
—— —— 30. 11h 15m P.M.	St. Ann's Bay, Jamaica.	A single violent shock from N. to S., lasting four seconds.	....	Preceded by a perfect calm; the air close and almost irrespirable. Thermometer at 85°. Birds and other animals showed decided signs of fear.	Ditto, vol. xx. p. 281.
—— Sept. 16.	In Grenada, especially at the city of Grenada.	Several severe shocks.	....	Grenada suffered considerable injury	v. Moll's Annalen, Bd. v. S. 328.
—— —— 21.	Jassy in Moldavia	Several shocks........	....	....	Hamb. Corresp. Nr. 179, Beil.
—— —— 23. 4 A.M. (P.M. according to v. Hoff.)	St. Malo (Ille et Vilaine), and at the rock of Cancale, at Grandville, Dinan, Saint-Servan, and other places on the coast.	At St. Malo a severe shock, followed at $5^h 13^m$ by a second of less violence. The motion was from N.E. to S.W., and lasted 10 to 12 seconds. At the other places mentioned it was from E. to W., and lasted about 43 secs.	This same day a terrible tempest extended over the German Ocean.	Accompanied at St. Malo by a noise like the rumbling of carriages on a wooden bridge. Some people were made sick by the motion, and dogs bayed. At the end of this mouth Vesuvius threw forth some lava again.	Journ. des Débats, 8 et 9 vendém.; Moniteur, 9 et 10 vendém. et 5 brum. an 13; Hamb. Corresp. Nrs. 162, 166; Cotte; v. Moll's Annalen, Bd. v. S. 328.
—— —— — At noon.	Tiflis in Georgia	A slight shock........	....	....	Dubois de Montpéreux, *loc. cit.*
—— —— — 8 P.M.	Ditto	A severe one	....	The day had been rather cloudy but agreeable. The following night first white frost was observed.	Ditto.
—— —— —	In the kingdom of Grenada.	The shocks recurred on this day.	....	....	v. Moll's Annalen, Bd. v. S. 328.
—— —— 24. 10 P.M.	Tiflis	An earthquake less violent than the last.	....	The day had been very fine	Dubois de Montpéreux, *loc. cit.*

2 A.M.		more severe.			
—— —— 29. 11 A.M.	Ditto	A *feeble* vibration, which is yet afterwards said to have been infinitely more severe than that of the 23rd. During the night there were four slighter shocks, in the intervals of which a slight motion of the earth was perceived.		Several walls fell. The day had been stormy, and the night rainy. The Moniteur (19 nivôse, an 13.) only mentions shocks on the days following:—24th at 8^h 35^m P.M.; 25th at 9^h 10^m P.M.; 26th at 1^h 25^m, and 29th at 8^h 40^m and 10^h P.M. None of these probably are separate events from those recorded in this catalogue, and seem less likely to be accurate as to date.	Ditto.
—— —— 30. 4 and 8 A.M. and 2 and 10 P.M.	Ditto	Four slight shocks at the hours mentioned.			Ditto.
—— Oct. 1. After midnight, and	Ditto	Another shock			Ditto.
—— —— —— Between 6 and 9 P.M.	Ditto	Three shocks			Ditto.
—— —— 2. 3 A.M.	Ditto	A slight shock		The days were now very cold and rainy	Ditto.
—— —— 5. In the evening.	In Tuscany, in the valley of Elsa, particularly at Colle, Poggibonsi, and S. Gemignano.	Ditto. There were several others in the course of the month.			Pilla, Istoria del tremuoto, &c.
—— —— 6. 10 P.M.	Tiflis	Another shock			Dubois de Montpéreux, *loc. cit.*
—— —— 7. After midnight.	Ditto	Another, very severe.			Ditto.
—— —— Night between 10 and 11.	Ditto	A slight vibration			Ditto.
—— —— 14.	Sienna and the neighbourhood.	Very violent		The inhabitants of several villages were obliged to sleep in the open fields.	Moniteur, 20 brum. an 13; Moll's Annalen, Bd. v. S. 328.

1.	2.	3.	4.	5.	6.
1804. Oct. 16. 7 A.M. and 9 P.M.	Tiflis	Renewed shocks			Dubois de Montpéreux, *loc. cit.*
—— —— 17. 9 A.M.	Ditto	Another shock		The 15th was a very warm day; in the evening there was a violent storm with sudden gusts of wind. This continued on the 16th and 17th. The 18th was rainy and cold. From the evening of the 20th up to midnight of the 21st the rain was very heavy, after which there came a terrible tempest lasting till noon next day.	Ditto.
—— —— 18. 9 P.M.	In Tuscany, in the valley of Elsa, and the places mentioned together above.	The most severe of all the shocks felt this month.		Accompanied and followed by *rombi* or dull aërial noises. Some damage was done in this district, and the inhabitants had to quit their houses.	Pilla, *loc. cit.*
—— —— 20.	Sienna and its neighbourhood.	Very violent			Moniteur and v. Moll, *loc. cit.*
—— —— 22. 2 A.M.	Tiflis	Some slight shocks		During a storm	Dubois de Montpéreux, *loc. cit.*
—— —— 23.	In the island of Jersey, and at St. Malo, and several French seaports.	Renewed shocks		Perhaps only a mistaken account of the event of *Sept.* 23.	v. Moll, *loc. cit.*
—— Nov. 6. Midnight.	Tiflis	A violent vibration		On the morning of the 7th the first snow fell	Dubois de Montpéreux, *loc. cit.*
—— —— Night between 22 and 23.	Region about Vesuvius	A violent shock		The volcano had been pretty quiet for some weeks, but immediately after this shock it burst forth into eruption. On the 24th the stream of lava had sensibly diminished.	Hamb. Corresp. Nr. 207, Beil.
—— —— 30. Midnight.	Tiflis	Three shocks, of which one was violent.		Much snow fell during the night	Dubois de Montpéreux, *loc. cit.*
—— Dec. 14. 2 A.M.	Leghorn	One shock		Caused no damage	Hamb. Corresp. 1805, Nr. 3.
—— —— 17. 9 P.M.	Valley of Elsa in Tuscany, and the other places mentioned together above.	Another severe shock. The undulations appeared to come from the S.W.			Pilla, *loc. cit.*
—— —— 18. About 6 A.M.	Leghorn	Two slight shocks, the first more considerable than the second.			Journ. des Débats, 13 Nivôse; Moniteur, 1 Pluviôse, an. 13.

		A third was *suspected* about 4 P.M.			
1805. Jan. 12. 7 P.M.	Vale of Clwyd in North Wales.	Lasted two or three seconds.			Gentleman's Magazine, vol. lxxv. p. 173.
—— ——	Leghorn	Vibratory			v. Moll's Annalen, Bd. v. S. 328.
—— Feb. 11. 10h 45m A.M.	Vitré (Ille et Vilaine)...	One shock; several, however, were felt at other places near.		Preceded by an extraordinary noise lasting five or six seconds, and ending with a loud explosion and the shock.	Journ. des Débats, 4 Ventôse; Moniteur, 5 Ventôse, an 13; Cotte.
—— —— ——	Sigmaringen in Swabia.	One shock			Cotte.
—— —— 21. 4h 45m A.M.	Tiflis in Georgia	An earthquake, lasting nearly half a minute, and consisting rather of oscillations (*balancements*) than of actual shocks. Followed by slight shocks at 5h 30m A.M., and another slight one at 10 P.M.		The weather was very fine, but towards evening it became bad, and the wind was very cold.	Dubois de Montpéreux, *loc. cit.*
—— Mar. 21.	Innspruck	A violent shock		Here and there cracks were produced in the walls.	Hamb. Corresp. Nr. 59, Beil.
—— ——	In England	Vibratory shocks			v. Hoff.
—— May 9.	Strasburg, Bischweiler, and Hagenau.	A slight vibratory shock.			Hamb. Corresp. Nr. 85.
—— —— 10.	Tönningen in Jutland...	An earthquake shock was *supposed* to have been felt.	During a terrible storm in the German Ocean, which did great damage to shipping.		Ditto, Nr. 77, Beil.
—— —— 16. 9 P.M.	Again at Bischweiler, Hagenau, and the surrounding district.	Vibratory, in the direction of the course of the river Moder.			Ditto, Nr. 85.
—— —— 21.	In Kamtschatka	Shocks during a min.			Ditto, Nr. 146; Moniteur, 21 Sept. 1806.
—— —— 30.	Ditto	Renewed shocks, more violent than the former, and lasting several minutes.		The bells sounded of themselves	Ditto.
—— July 3. At sunrise.	Island of Candia. Also felt in Sicily.	An earthquake consisting of four severe shocks in the space of 8 minutes.		The towns of Canea and Retimo suffered most damage.	Hamb. Corresp. Nr. 147; v. Moll's Annalen, Bd. vi. S. 538; Cotte; Keferstein; Moniteur, 18 Fruct. an. 13.

1.	2.	3.	4.	5.	6.
1805. July 3.	About Etna	....	....	Perhaps the shocks in Sicily mentioned by Cotte and Keferstein as contemporaneous with those in Candia, are the same with the earthquake here given.	Ann. de Chim. et de Phys. t. xxi. p. 400.
——— 24. $6^h 25^m$, $6^h 37^m$, and $10^h 10^m$ A.M.	Eisenartz in Styria	Three vertical shocks at the hours mentioned, without oscillation.	....	The air was calm and close. At noon rain began, which lasted all the following night.	Moniteur, 2–8 and 12 Fruct. an 13; Journ. des Débats, 4 Fruct.; Hamb. Corresp. Nr. 131; Cotte.
——— 26. 2 and 6 A.M.	Rome	Slight shocks. The motion appeared to come from the Apennines.	....	....	Journ. des Débats, 28–30 Thermidor, 7, 8, 11, 21, 23 Fructidor, an 13; 3, 11 Vendém. an 14; Moniteur, 27 Thermidor, 3, 4, 12, 16, 18, 24, 29 Fructidor, 1 complém. an 13; 11 Vendém. an 14; Bibl. Brit. t. xxix. p. 389, et t. xxx. p. 259; Journ. de Phys. t. lxi. p. 225; v. Buch, Canar. Inseln, S. 333; v. Moll's Annalen, Bd. vi. S. 538; Hamb. Corresp. Nr. 135, 136, 137, 140.
———— $9^h 57^m$, 11 P.M., and ¾ hour after midnight.	Naples, and throughout La Puglia, Calabria, and the Terra-di-Lavoro. Most violent in the province of Molise, and extending even to Rome.	A most destructive earthquake. At Naples three shocks at the hours mentioned. The first lasted 45 to 50 seconds, with increasing intensity, in the direction N. to S. The second shock was less violent, and the third still less so. Three more shocks were felt during the three following days. According to other accounts, the first shock at Naples consisted of several di-	About 10 P.M. the sea at Naples was agitated, small eddies or whirlpools were observed at the surface, and a person bathing felt the sand move beneath his feet, and saw a shoal of fish swimming on the surface of the water.	The heat at Naples was most oppressive. At 7 in the morning there had been a storm from the N.W., and at $8^h 30^m$ in the evening a cool breeze from the N. blew for an hour. The heavens were clear, but a slight mist covered the surface of the ground. The barometer stood at 29·9 inches. Some buildings in Naples were injured, and a few fell. In La Puglia and Calabria these shocks were but slightly felt, but to the north of Naples they were very violent. In the Terra-di-Lavoro, Aversa, Capua, and Caserta were most injured. In Molise the town of Isernia became a heap of ruins. Avellino, Benevento, and Bojano in Capitanata suffered greatly. On the east of the Apennines, Campobasso, S^{ta} Agatha, Aquila and Chieti experienced some damage, the last being the most northern place where the earthquake seems to have been sensible.	Ditto.

		stinct blows, separated by undulatory motion, and lasting altogether 68 secs.		At Foggia also some damage was done. Soon after the shocks, the water of a spring on the mountain of Cassino became sulphureous. At Bojano a lake appeared. Vesuvius merely sent forth smoke during this earthquake, but after the second shock a double explosion as of cannon was heard from the mountain. In this month Etna burst into eruption.	
1805. July 26. At the end of the month.	Some of the Antilles, especially Antigua.	Several shocks		Antigua suffered most from these shocks	Hamb. Corresp. Nr. 156.
—— Aug. 11. 7 P.M.	East Haddam, Connecticut.	Two slight shocks		Preceded by a thunderstorm at 4 P.M.	Silliman's Journal, vol. xxxix. p.339.
—— ——	Around Vesuvius	Some slight shocks		Followed, the next day, by an eruption of extreme violence. The lava especially was of most unusual fluidity, and traversed a space of 26,000 Neapolitan palms (=22,360 Engl. feet) in five hours.	v. Buch, Geogn. Beobacht. auf Reisen, u. s. w. Th. ii. S. 218.
—— —— 14.	In the province of Molise, kingdom of Naples.	One shock			Journ. des Débats, 3 Vendém.; Moniteur, 7 et 11 Vendém. an 14.
—— —— 18.	Ditto	Ditto			Ditto.
—— —— 6h and 7h 15m A.M.	Island of Oléron	Two shocks at the hours mentioned.			Journ. des Débats, 4 et 5 complém. an 13; Cotte.
—— —— 19.	Eger (in Bohemia?)	Vibratory			Cotte.
—— Oct. 13.	Naples and the neighbouring country.			At Capua and Nola several buildings fell. On the 15th Vesuvius was in eruption.	Journ. des Débats, 14 Frum.; Moniteur, 15 Frum. an 14.
—— Nov. At the beginning of the month.	Constantinople	An earthquake		Accompanied by an epidemic	Moniteur, 18 Février, 1806.
—— —— 30. In the morning.	Coire in the Grisons	Several shocks			Journ. des Débats, 2, et Moniteur, 3 Nivôse, an 14; Cotte.
—— Dec. 26.	In the district of Bulte near Hanover.	A vibratory shock		Accompanied by a loud explosive noise	Hamb. Corresp. 1806, Nr. 2.
—— —— 30. 6 A.M.	East Haddam, Connecticut.	A slight shock			Silliman's Journal, vol. xxxix. p. 339.
——	In the Morea	An earthquake			v. Hoff.
——	Sta Fé di Bogota in Columbia.	A violent earthquake.		From this year until 1807 there were repeated eruptions of the volcano of Isalco in Guatemala. (Annalen der Physik, Bd. lxxxvi. S. 539.)	Allgemeine Zeitung, 1826, Nr. 260, Beil, S. 1042.

1.	2.	3.	4.	5.	6.
1806. Jan. 20. 15ᵐ past midnight.	Orgon in the department Bouches-du-Rhône.	Two shocks in 20 secs., the first of which was much more violent than the second.		Accompanied by a dull noise, like the explosion of cannon, at each shock. Cotte gives the date Jan. 19.	Journ. de l'Empire, 20 Févr.; Cotte.
—— —— Night between 23 and 24.	Poitiers	Two very severe shocks, the second less so than the first. Direction S. to N.		Both accompanied by a dull and prolonged sound.	Journ. de l'Empire et Moniteur, 13 Févr.; Cotte.
—— Mar. 2.	Novellara in Italy				Cotte in Journ. de Physique, t. lxv.
—— April 9 and 10.	Reggio and other places in Calabria Ulteriora.	Rather violent shocks.		Some houses were injured	Moniteur, 6 Mai; Journ. des Débats, 7 et 26 Mai; Cotte.
—— May 1.	Barbadoes				Cotte, *loc. cit.*
—— —— 27.	At Etna	An earthquake			Ann. de Chim. et de Phys. t. xxi. p. 400.
—— —— 31?	Vesuvius	A slight shock		The eruption which occurred this day was *preceded* by the shock. It perhaps occurred a day or two before.	Moniteur, 26 Juin.
—— June 19. Between 11 P.M. and midnight.	Nice	A severe shock		The houses were much shaken	Journ. des Débats, 5 Juillet; Cotte.
—— July 21. 10ʰ 15ᵐ P.M.	In the kingdom of Naples.	At Naples the shock was slight, but more severe at Molise and Sora.			Journ. des Débats et Moniteur, 11 et 14 Août, 25 Févr. suiv.; Cotte.
—— —— 26.	Ditto	Another shock			Ditto.
—— Aug. 8. 5 (A.M. or P.M.?)	Krasnojarsk in Siberia	A terrible shock, lasting 4 min. 15 sec.; followed by a second a little later.	The river Jenissei inundated its banks.	A violent storm intervened between the two shocks. A mountain at the distance of 12 wersts from Krasnojorsk was replaced by a lake of 300 feet in circumference and 180 feet in depth in some places, the water in which had the taste and smell of sulphur. The country was covered with volcanic ashes.	Moniteur, 26 Oct.; Journ. des Débats, 3 Déc.
—— —— 26 to 30.	Rome and its neighbourhood, extending as far as Naples. The centre of disturbance appeared to be the mountain of La Fajola.	Violent shocks, constituting the most terrible earthquake which Rome had experienced since 1703.		Caused great damage. One shock was so violent that the senator Lucien was thrown out of his bed. At the mountain of La Fajola a lake of sulphurous water was formed.	Journ. des Débats, 15 et 25 Sept.; Moniteur, 16 et 26 Sept.; Cotte.

8^h 45^m P.M.	Buda, Hungary. Also felt at Komarom (Komorn?).				Moniteur, 12 Oct.; Cotte.
—— Oct. 6.	Gerace in Calabria Ulteriora.	A severe shock			Moniteur, 14 Nov.
—— —— 10.	At Etna	An earthquake			Ann. de Chim. et de Phys. t. xxi. p. 400.
—— Nov. 1 to 18.	Grenada in Spain	Violent shocks		Several houses were injured; and a village was ruined, and replaced, it was said, by a new river.	Moniteur, 1–4 Déc.; Cotte.
—— —— 28.	Komarom (Komorn?) in Hungary.	Another earthquake			Férussac, Bull. des Sciences Naturelles, t. xviii. p. 195.
—— Dec. 12.	Bâle				Mérian.
—— —— 17. 10^h 43^m P.M.	Ulm	A violent vertical shock, lasting three seconds.		The weather was calm	Journ. des Débats, 27 Déc.; Moniteur, 28 Déc.
—— —— Night between 18 and 19.	Bitonto and Trani in the kingdom of Naples.	A violent shock from S. to N.			Journ. des Débats, 11 Janv.; Moniteur, 12 Janv. 1807; Cotte.
—— —— 25.	Throughout the Terra-di-Bari, kingdom of Naples.	Several severe shocks.			Journ. des Débats, 21 Janv. 1807; Cotte.
—— At the end of the year.	Blesle and Ardes in the departm. Haute-Loire.	A slight shock			Moniteur, 19 Févr. 1808.
1807. Jan. Night between 14 and 15.	Pau in the Pyrenees	Three rather violent shocks.			Journ. des Débats, 25 et 31 Janv.; Moniteur, 31 Janv., 5 et 19 Févr.
—— —— 15.	Bayonne and the environs.	A shock in the direction S.W. to N.E. At Sarrance there were five shocks.			Ditto.
—— —— Night of 27 and 28.	In the territory of Molise, kingdom of Naples.	A shock of four secs. duration; nearly as violent as that of the 26th July preceding.			Moniteur, 25 Févr.
—— Feb. 19 and 20. (At night?)	Darmstadt				A catalogue communicated to M. Perrey by M. Studer, Professor of Geology in the University of Berne.
—— —— 21.	At Etna	Another shock of earthquake.			Ann. de Chim. et de Phys. *loc. cit.*

1.	2.	3.	4.	5.	6.
1807. Feb.	Cahors in the departm. Lot.	A shock from the S.E., but slightly felt.		Probably the same as that of Feb. 8, 1808	Delpon, Statistique du Lot, t. i. p. 108.
—— ——	Janina in Epirus	One earthquake shock during this month.		M. Pouqueville says that this country (Epirus) is perhaps the district of Europe in which earthquakes are most frequent. The shocks, according to him, do not extend more than 20 leagues from the sea, and are stopped at the foot of Mount Pindus, so that they are never felt in the Polyanos, at Calarites, at Syraco, or in the higher regions where the rivers take their rise.	M. Pouqueville in Ann. de Chim. et de Phys. t. xlii. p. 408.
—— Mar. 30. 11h 13m A.M.	In the northern part of the Puy-de-Dôme.	A severe shock, extending over a surface of about 4 myriamètres in length.		Some old ruins were thrown down, and clocks were stopped.	Journ. des Débats, 30 Avril; Moniteur, 1 Mai.
—— ——	Janina in Epirus	On *four* days during the month shocks occurred.			Pouqueville, *loc. cit.*
—— April.	Ditto	*Five* days in this month were marked by shocks.			Ditto.
—— May.	Ditto	Shocks on *four* days			Ditto.
—— June 6. 4 P.M.	Lisbon. Also at Oporto, and in other parts of Portugal.	A violent shock, said to be comparable to the great one of 1755, and followed immediately by a second. Duration =10 or 12 seconds. The motion was horizontal and vertical, but badly observed.	The sea remained calm. The shock was felt on board a frigate 8 leagues off the Rock of Lisbon.	No disasters ensued from this earthquake. The Annual Register gives the date 6th *July*, and says that several houses were thrown down.	Journ. des Débats, 28 et 30 Juin; Moniteur, 29 Juin; Annual Register, vol. i. p. 174.
—— —— 17.	Eglisau in the canton of Zurich.	An earthquake			M. Studer's catalogue quoted above.
—— July 14.	Lahr or Lohr in Swabia.	A rather violent shock.		Some of the buildings rocked violently	Journ. des Débats, Juillet 30; et Moniteur, 31 Juillet.
—— August.	Janina in Epirus	One shock during the month.			Pouqueville, *loc. cit.*

$1^h\ 4^m$ A.M. (At Coni, $1^h\ 30^m$.)	country for six leagues round.				teur, 16 et 30 Sept.
—— —— 11. $8^h\ 30^m$ P.M., midnight, and 3, the next morning.	Neuwied on the Rhine	The first of the three shocks felt was violent, horizontal, and in the direction S.W. to N.W. (?) The two others were slighter, the third being the least violent of all.	The Rhine was agitated, and fish leaped out of the water.	The first shock was scarcely felt in houses situated on the north side of a street, while those on the other rocked violently; accompanied by a noise like that of a carriage rolling rapidly on pavement. Immediately after, the wind ceased, and the sky became overcast with clouds.	Journ. des Débats, 27 Sept.; Moniteur, 28 Sept. et 9 Oct.; Gentleman's Magazine, vol. lxxvii. p. 964.
—— ——	Janina in Epirus	Shocks on *two* days of this month.			M. Pouqueville, *loc. cit.*
—— Oct. 1. 2 A.M.	Vienna	Some slight earthquake shocks.		Accompanied by a terrible tempest	Moniteur, 16 Oct.
—— Nov. 18.	Algiers	A violent shock, followed by others each night up to the 26th.		Buildings were thrown down	Journal de l'Empire (same with Journ. des Débats), 22 Févr.; Moniteur, 21 Févr. et 15 Mars, 1808.
—— —— 25.	At Etna	Another vibration			Ann. de Chim. et de Phys. *loc. cit.*
—— Dec. 19. $2^h\ 30^m$ A.M.	Bielle, and in the mountains of Oropa, Lombardy.	A rather violent shock from N.E. to S.W.		At Ivrée the shock was most strongly felt in the lower parts of the town and near the river. Doors were thrown open, and pictures fell to the ground.	Vassali-Eandi, *loc. cit.* pp. 64 et 131.
—— —— 22. 3 A.M.	Dusseldorf and its environs.	Two shocks		Preceded by a noise like that of a great number of carriages rolling over pavement. The weather was calm and hazy.	Journ. des Débats et Moniteur, 1 Janv. 1808.
—— ——	Weston, Connecticut			Accompanied by a remarkable meteor	Silliman's Journal, vol. xxxix. p. 336.
1808. Jan. 8.	Dunnichen in Scotland	Several shocks			Mém. de Chronol. t. ii. p. 932.
—— Feb. 8. $4^h\ 30^m$ A.M. ($4^h\ 45^m$ at Cahors.)	Brioude in the departm. Haute-Loire. Also felt at Cahors, Nîmes, Montpellier, Saumur, and slightly at Blesle and Ardes.	A shock in the direction N. to S., followed, a few minutes afterwards, by another of less violence. At Cahors the motion was rather violent, and lasted two or three seconds.		The first shock was accompanied by a disturbance of the air like that caused by a cannon-shot. Several people suffered from a violent headache in consequence.	Journ. des Débats, 16, 19, 20 et 21 Févr.; Moniteur, 19 Févr.; Travaux de l'Acad. du Gard. An. 1808, p. 180.

1.	2.	3.	4.	5.	6.
1808. Feb. 27. Towards midnight.	Semlin and Belgrade ...	Three rather violent shocks.	....	....	Journ. des Débats, 29 Mars; Moniteur, 30 Mars.
—— ——	Janina in Epirus	One shock during the month.	....	....	Pouqueville, *loc. cit.*
—— Mar. 4. 5h 20m P.M.	Ile Dieu (off the coast of Poitou).	A violent shock, lasting 14 seconds.	....	Two enormous masses of rock fell into the sea ..	Journ. des Débats et Moniteur, 28 et 29 Mars.
—— —— 27. 5h 15m A.M.	Strasbourg	A violent shock	....	A strong wind was blowing	Moniteur, 1 Avril; Journ. des Débats, 2 Avril; Studer.
—— April 2. In Piedmont, at 5h 43m P.M.; at Grenoble and Berne, 5h 30m; and at Aix about 5h 20m; at Marseilles, 5h 25m.	In Piedmont, throughout the valleys of the Palice and Clusone, and as far east as Milan; extending over almost the whole valley of the Rhone, as far as Montbrison and Berne. The centre of disturbance seems to have been at Pignerol.	More violent in Piedmont than further N. and W. The directions given are N.W. to S.E. at Turin, N.E. to S.W. at Nice, S. to N. at Chambéry, N. to S. at Grenoble, S.S.W. to N.N.E. at Gap, and E. to W. at Briançon and Marseilles. At Chambéry the duration of the motion was estimated at 10 to 15 seconds, at Grenoble about 40 secs., at Gap 90 secs., at Marseilles 3 shocks in 19 secs. (the first was the slightest, and lasted 4 secs.; an interval of 2 secs. then elapsed, followed by the second shock, of 8 secs. duration; then another interval of 2	At Marseilles it was said that the water in the canal of the arsenal experienced a triple flux and reflux, so that the water rose about 6 inches above the mean level of the sea.	This very severe shock, the first of the many felt in Piedmont during April and May, caused some damage to buildings at places in the north of Italy. These shocks seem, according to M. Muthaon, to have taken the general direction N. to S. or S. to N. in the district from Pignerol to La Perouse, or rather S.W. to N.E., parallel to the Alps. At Turin the shocks were much less frequent. Some were accompanied by noise, others not. The former seemed to shake the houses more violently than the latter, even when the actual motion of the earth was slighter. The noise always immediately preceded the shock. The effects varied greatly between places at short distances from each other. In general the motion was felt more distinctly in houses built upon solid rock, but those standing on loose foundations suffered most actual injury. It was also remarked, that buildings, like belfries, which had small bases were generally but little injured. It was observed that a number of walnut-trees, torn up by the violent gusts of wind, had their trunks all directed towards the north, though this probably had no connexion with the earthquake. Several luminous meteors were seen during the period of these shocks. The inhabitants of the valleys of the Clusone and	Vassali-Eandi's account of these shocks, addressed to the Imp. Acad. of Turin, 1808; Journ. des Mines, t. xxiii. p. 209; Journ. des Débats, 9, 11, 12, 14, 15, 19, 24, 25, 26 Avril, et 2, 6, 9 Mai; Moniteur, 9, 10, 11, 13, 14, 15, 16, 17, 19, 23, 25, 28, 29 Avril, et 3, 5, 7, 10, 18 Mai; Correspondance Vaudoin; Studer's catalogue.

		Aix two shocks in 5 secs. At Abries 30 shocks were felt on this day.		the wind was cold and violent from the N.W. There had been a little snow at 4 and 5 P.M. The barometer at noon stood at 27 in. 1·2 line, and at 8 P.M. at 27 in. 2·2 lines. At the hospice on Mont Cenis several articles of furniture were displaced, and a noise like that of carriages was heard at the same time. At Geneva a bell was caused to sound. At Grenoble also a bell sounded twice, loudly and distinctly. At Mâçon and Montbrison the shock was slight. At Gap the great bell of the town sounded, and bells rang in many rooms. Several houses were injured at St. Jacques and in the hamlet of Sechier. At Corps and several other communes of the Upper Alps, the shock was preceded by a noise in the air like the collision of an innumerable number of stones. At Briançon 7 or 8 chimnies and some old walls were thrown down, and the large bell sounded thrice. At Abries a part of the belfry fell. At Marseilles the sky was clear, the thermometer stood at 4° below temperate, and the barometer, which had been at 28 inches, fell suddenly 2 lines, rising again during the following night to 28 in. 3 lines. The wind sensibly abated after the earthquake. The sky became clouded during the night, and some drops of rain fell in the afternoon of next day. At Toulon the machine for putting masts on board vessels (shears?) was raised more than an inch above its ordinary position by the shock. In Piedmont generally at the time of this first shock the weather was fine, settled, and dry: the nights were cold, and rain was much wished for, both for agricultural purposes and to supply the wells, which were for the most part dry.	

1.	2.	3.	4.	5.	6.
1808. April 2. $9^h\ 15^m$ P.M. On Mont Cenis at 9^h. At Briançon at $9^h\ 30^m$, as also at Embrun.	The valleys of Piedmont above mentioned, the centre being, according to Vassali-Eandi, at Abries.	Less violent than the former shock.		Accompanied on Mont Cenis by the same noise as before.	Authorities quoted above (on the 2nd).
— — 3. $9^h\ 30^m$ A.M.	At La Tour	Moderate			Ditto.
— — — 10 A.M.	Barga	Ditto			Ditto.
— — — 5 P.M.	Ditto	Severe. There were several other shocks during the day.		A dull tremulous noise was frequently heard during the day.	Ditto.
— — 4. 1 A.M.	Ditto	Moderate		Besides the shocks mentioned, slight tremulous motion was very frequent at this place, as well as the noise like a subterranean cannonade, which recurred on the following days.	Ditto.
— — — 10 A.M.	Ditto	Ditto			Ditto.
— — — 2 P.M.	Ditto	Ditto			Ditto.
— — — 6 P.M.	Ditto	Ditto			Ditto.
— — — 9 P.M.	Ditto	Severe			Ditto.
— — — Midnight.	Ditto	Moderate. From the 2nd to the 4th there were seventy-five shocks felt at La Tour; they appeared to come from the east.			Ditto.
— — 5. 1 A.M.	Ditto	Moderate			Ditto.
— — — 10 A.M.	Ditto	Ditto			Ditto.

808. April 5. 3 P.M.	La Tour	Slight. Other slight shocks had been felt during the night between the 4th and 5th.			
— — — 6 P.M.	Barga	Severe			Ditto.
— — 6. 1 P.M.	At Lisbon	Several slight shocks.			Journ. des Débats, 28 Avril; Moniteur, 29 Avril.
— — —	Barga	Slight but very numerous shocks during the day.			Vassali-Eandi's Account, &c.
— — 7.	Ditto	Ditto			Ditto.
— — 8. 11h 30m P.M.	Pignerol	Moderate. Forty shocks had been counted since the 2nd.		At Barga there were subterranean noises like explosions of cannon heard during the day, but no motion was felt. In the evening a terrible storm, which lasted about three hours.	Ditto.
— — 9. 6 A.M.	Barga	Moderate. Several other slighter shocks were observed.			Ditto.
— — — 9 P.M.	Ditto	Ditto			Ditto.
— — — 11 P.M.	Pignerol	Ditto		Preceded by a loud noise, as usual	Ditto.
— — 10. 6 A.M.	Barga	Slight			Ditto.
— — — 10h 38m A.M.	La Tour	Rather severe		Slight tremblings and noise were frequent during the day. Since the 2nd of the month the shocks appeared to decrease in violence at this place, whereas they recovered their intensity in some degree in the valley of the Po.	Ditto.
— — — 11 A.M.	Barga	Slight			Ditto.
— — — 3 P.M.	Ditto	Ditto			Ditto.
— — — 9 P.M.	Ditto	Ditto			Ditto.
— — — Also at 9 P.M.	La Tour,	Two rather severe shocks.			Ditto.

1.	2.	3.	4.	5.	6.
1808. Apr. 11. 10 minutes past midnight of the 10th.	La Tour	Violent			Vassali-Eandi's Account, &c.
— — — Also at $0^h 10^m$ A.M.	Briquerasque	A shock of greater severity than that of the 2nd.			Ditto.
— — — 2 A.M.	Ditto	Slighter than the last.		Slight noises were heard during the day	Ditto.
— — — 7 A.M.	Barga	Slight			Ditto.
— — — 1 P.M.	Ditto	Ditto			Ditto.
— — 12. $0^h 35^m$ A.M.	Ditto	Moderate		Several other feeble shocks during the day	Ditto.
— — — 2 A.M.	La Tour	Ditto. Similar shocks recurred during the day at intervals of about three hours.			Ditto.
— — — 3 A.M.	Perouse	Rather violent		There was a storm accompanied by thunder in the evening, followed by snow.	Ditto.
— — — 4 A.M.	La Tour				Ditto.
— — — 10 A.M.	Ditto				Ditto.
— — — 11 A.M.	Ditto				Ditto.
— — 13. In the morning.	Ditto	our moderate shocks			Ditto.
— — — 10 A.M.	Barga	A slight shock			Ditto.
— — — 10 P.M.	La Tour, Villars, and Bobbi.	Severe			Ditto.
— — — 11 P.M.	Ditto	Ditto			Ditto.
— — 14. 1 A.M.	Briquerasque	Slight			Ditto,

1808. Apr. 14. 3 P.M.	La Tour	Rather severe. There had been two feeble shocks during the morning, and twelve were reckoned in the course of this day and the following night.			Ditto.
— — — 3^{h} 15^{m} P.M.	Briquerasque	A disastrous shock			Ditto.
— — — 4 P.M.	La Tour	Severe			Ditto.
— — — 4^{h} 30^{m} P.M.	Revel or Revello	A violent shock, lasting two seconds.			Ditto.
— — — 5^{h} 20^{m} P.M.	Barga	Moderate			Ditto.
— — — 5^{h} 30^{m} P.M.	La Tour, and Lucerne	Very severe		More damage was caused by this shock	Ditto.
— — 15. 2 A.M.	Revel, Paesana, Barga, Cavour, and Lucerne. Also at La Tour, Turin, Saluces, &c.	Ditto		At the first-named places some damage resulted, at the last three however there was none.	Ditto.
— — — 2^{h} 15^{m} A.M.	Pignerol	Ditto. Followed by other shocks up to about 5 A.M.		Fresh damage done. The inhabitants quitted their houses.	Ditto.
— — — About 2 P.M.	Gap and Briançon				Ditto.
— — — 2^{h} 30^{m} P.M.	Briquerasque	A rather severe shock, preceded by some slight ones in the morning, and followed by some tremulous motion during the evening.			Ditto.
— — — 2^{h} 40^{m} P.M.	Turin	Moderate			Ditto.
— — — 3 P.M.	Barga, Nice, Revel, and in the valleys of Bronda, Wruita, and Maira, and those of the Po.	Severe. Lasted three seconds at Barga, at which place a wall oscillated from W. to E. Several		The damage caused by the shock of the 2nd was renewed almost everywhere by this one.	Ditto.

1.	2.	3.	4	5.	6.
		other shocks were felt there during the day. At Nice the shock was from N. to S., and lasted also three seconds. At Revel it lasted eight or nine secs.			
1808. Apr. 15. $4^h\ 30^m$ P.M.	Pignerol	Severe			Vassali-Eandi's Account, &c.
— — — $5^h\ 30^m$ P.M.	Ditto	Still more severe			Ditto.
— — — $7^h\ 30^m$ P.M.	Ditto	Similar to the last			Ditto.
— — 16. 1 A.M.	La Tour	Slight			Ditto.
— — — 2 A.M.	Ditto, and at St. Jean, and higher up the valley. Also at Nice.	Very violent. At Nice the shock was rather severe, from N. to S., and lasted 3 secs.		Fresh ruins were produced. Followed by continual dull rumbling noise and slight tremblings up to $5^h\ 30^m$ A.M.	Ditto.
— — — $2^h\ 15^m$ A.M.	Fenestrelle. Also felt at Geneva, Grenoble and Turin, and as far as Marseilles and Antibes.	At Fenestrelle this shock was very severe, and seemed to last longer than that of the 2nd. At Turin the motion was undulatory, from S.W. to N.E. (or W. to E.), and lasted 8 seconds, during which time there were four distinct shocks.			Ditto.
— — — $2^h\ 18^m$ A.M.	Acqui	Very severe			Ditto.
— — — $2^h\ 20^m$ A.M.	Barga	Severe, lasting more than eleven secs.		The wells were troubled, and some buildings were injured.	Ditto.
— — — $2^h\ 30^m$ A.M.	Ivrée, and throughout the department.	A severe shock, lasting twenty seconds.		No damage resulted from this shock	Ditto.

1808. Apr. 16. 3 A.M.	Briquerasque	Another severe shock. At Cavour there were two shocks between midnight and morning.		Accompanied by dull noises which continued on the following days. The inhabitants quitted their houses.	Ditto.
—— —— 17. $1^h\ 45^m$ A.M.	Nice	Moderate			Ditto.
—— —— — 2 A.M.	Paesana, Embrun, Briançon, Gap, and Corps (Isère).	Ditto. Direction at Embrun and Briançon = S.S.W. to N.N.E., lasting 12 secs. At Corps, fifteen oscillations were reckoned in 22 secs., the latter ones terminating by a kind of bound.		It was remarked that the shocks were felt most violently in valleys among the mountains.	Ditto.
—— —— — 3 A.M.	Ivrée	Slight. Duration = 3 secs.			Ditto.
—— —— — 2 P.M.	Crissolo, and near the Pic de Viso.	Feeble			Ditto.
—— —— — 6 P.M.	Cavour	Two or three little shocks. At Barga several oscillations and more tremulous motion during the day.			Ditto.
—— —— — 10 P.M.	Ditto	Two little shocks			Ditto.
—— —— 18. 1 A.M.	Ditto	Another			Ditto.
—— —— — 3 A.M.	Nice	Moderate, from N. to S., lasting 3 secs.			Ditto.
—— —— — 4 A.M.	Cavour and Barga	Violent. Some more slight motion was felt about noon.		At La Tour, at the same hour, two distinct detonations were heard, and a luminous meteor was observed.	Ditto.
—— —— — About dawn.	Fenestrelle. The first shock was felt also at Pignerol.	Three shocks		At Fenestrelle some arches were injured. At Pignerol the inhabitants encamped in tents.	Ditto.
—— —— — $4^h\ 15^m$ P.M.	Barga	Moderate			Ditto.

1.	2.	3.	4.	5.	6.
1808. Apr. 18. 8 P.M.	La Tour	Slight. Followed by another shock a little after, and by three more slight ones during the night.			Vassali-Eandi's Account, &c.
—— —— 19. 0h 45m A.M.	Barga	Moderate			Ditto.
—— —— — 3 A.M.	Ditto	Ditto			Ditto.
—— —— — 4 A.M.	Ditto	Feebler			Ditto.
—— —— — About noon.	La Tour	Four slight shocks. Several others during the day.			Ditto.
—— —— 20. 2 A.M.	Barga	Slight			Ditto.
—— —— — 3 A.M.	Ditto	Ditto			Ditto
—— —— — 4 A.M.	Ditto	Ditto			Ditto.
—— —— — 6h 15m A.M.	Pignerol				Ditto.
—— —— — 10 A.M.	Ditto, and at Barga	Severe		The buildings suffered fresh injuries	Ditto.
—— —— — 10h 15m A.M.	Briquerasque	Ditto. Followed by several slighter shocks during the day and night.			Ditto.
—— —— — 10h 30m A.M.	Lucerne and Saluces. Also felt at Pacalieri and La Tour.	Very severe. Direction at Lucerne N.E. to S.W. Several slight movements there during the following night. At Saluces the shock lasted 5 or 6 seconds. At Pacalieri and La Tour several others		Accompanied at Saluces by a dull noise. At Lucerne fresh ruins were produced.	Ditto.

		had been felt during the preceding night.			
1808. Apr. 20. 10 P.M.	Nice	Slight			Ditto.
—— —— 21. 2^h 30^m A.M.	Pignerol				Ditto.
—— —— —— 5 A.M.	Barga and Briquerasque.	Rather severe		Two detonations heard during the following night.	Ditto.
—— —— —— 5^h 15^m A.M.	Saluces	Slight			Ditto.
—— —— —— 5^h 20^m A.M.	Pignerol				Ditto.
—— —— 22. 7^h 15^m A.M.	La Tour	Moderate		Dull rumblings were observed three or four times during the preceding night.	Ditto.
—— —— —— 9^h 45^m A.M.	Ditto	Slight			Ditto.
—— —— —— During the morning.	Barga	Three trifling shocks		About 3 P.M. a waterspout passed over the territory of Marennas.	Ditto.
—— —— —— Midnight.	Ditto	Slight		A storm of thunder and hail during the day	Ditto.
—— —— 23. 6 A.M.	Briquerasque and Pignerol, and at Revello.	Ditto. Most perceptible at Revello, where the earth trembled many other times during the day.			Ditto.
—— —— 24. 9 P.M.	Briquerasque	Severe; followed by two feeble shocks during the night.			Ditto.
—— —— —— 9^h 15^m P.M.	Barga	Very severe. Other slighter shocks during the day.			Ditto.
—— —— 25. At night.	Ditto	Slight shocks			Ditto.
—— —— 26. 7^h 45^m P.M.	Ditto	Ditto. Similar ones felt at Pignerol during the day.			Ditto.
—— —— 27. 11^h 30^m A.M.	Saluces	Slight			Ditto.

1.	2.	3.	4.	5.	6.
1808. Apr. 27. $2^h\ 30^m$ P.M.	Barga	Slight			Vassali-Eandi's Account, &c.
—— —— 28. 1 A.M.	Pignerol	Rather severe			Ditto.
—— —— — 2 A.M.	Briquerasque	Slight		Accompanied by rumbling noise	Ditto.
—— —— — $2^h\ 30^m$ A.M.	Barga	Moderate.		Attended with subterranean noise lasting 30 seconds.	Ditto.
—— —— 29. 4 A.M.	Ditto, and at Briquerasque.	Slight at Barga, and still more so at Briquerasque.			Ditto.
—— —— — $9^h\ 12^m$ A.M.	Pignerol	Two shocks of considerable severity.			Ditto.
—— —— 30. 1 A.M.	Briquerasque	Slight shocks, recurring at 4 A.M.			Ditto.
—— —— — Between 2 and 3 A.M.	La Tour	Two rather severe shocks.			Ditto.
—— —— — 3 A.M.	Barga	Moderate		Accompanied by noise like that of a cannonade, ending with two explosions.	Ditto.
—— —— — $11^h\ 45^m$ A.M.	Pignerol	Very severe			Ditto.
—— —— — $7^h\ 30^m$ P.M.	La Tour	Slight		Noises had been constantly heard at this place since the 24th, but no shocks, except the two on the morning of this day	Ditto.
—— May 1. $0^h\ 15^m$ A.M.	Pignerol	Very severe			Ditto.
—— —— — $0^h\ 20^m$ A.M.	Saluces. More perceptible in the valley of the Po.	Slight, in the direction W. to E.			Ditto.
—— —— — 1 A.M.	Barga	Moderate.			Ditto.
—— —— — 2 A.M.	Ditto	Ditto			Ditto.
—— —— — $3^h\ 45^m$ A.M.	Pignerol	A shock of greater intensity than that of 15 mins. past midnight. Some feebler ones during the day.		Accompanied by noise	Ditto.

1808. May 1. 10 A.M.	Briquerasque	Slight		For some days before this, Villars, Bobbi, and other villages situated towards the upper part of the valley of the Palice were more violently shaken and suffered more damage than others lower down towards the plain.	Ditto.
— — — About 6 P.M.	Barga	Slighter than that of 1 A.M.		On this day a volcano opened in the island of St. George, Azores. The eruption was of great violence, and did not cease before the 5th of June. Philosophical Transactions of New York, 1815, p. 315.	Ditto.
— — 2. 2 A.M.	Ditto	Slight shocks			Ditto.
— — — 3 A.M.	Ditto				Ditto.
— — — 4 A.M.	Ditto	This shock and the last were not equal in intensity to one-seventh of that at 2 A.M.			Ditto.
— — — 3h 30m P.M.	Pignerol	Slight			Ditto.
— — — 5 P.M.	Briquerasque	Ditto. Several very slight shocks between midnight and morning.			Ditto.
— — 3. 3 A.M.	Saluces. Also felt at Pagno.	Undulatory, from W. to E.			Ditto.
— — — 3h 15m A.M.	Coni	Violent			Ditto.
— — — 4h 30m A.M.	Barga	Slight shocks; several were felt between 4 and 5 A.M.			Ditto.
— — — At dawn.	Briquerasque	Slight shocks			Ditto.
— — 4. 2h 20m (A.M. or P.M.?).	Barga	Very slight			Ditto.
— — — 3 (A.M. or P.M.?).	Ditto	Ditto			Ditto.

1.	2.	3.	4.	5.	6
1808. May 5. 2 A.M.	Barga, and at Briquerasque.	At Barga a single shock; at Briquerasque several very slight ones.			Vassali-Eandi's Account, &c.
— — — 4 A.M.	Barga	Another slight shock.			Dit
— — — 3h 30m to 5 A.M.	La Tour	Three slight shocks in the time mentioned. Nothing had been felt at this place for 48 hours before.		One of these shocks was accompanied by an explosion like the report of a cannon.	Ditto.
— — — 9 A.M.	Briquerasque	Slight			Ditto.
— — — 11 A.M.	Pignerol, Barga, Cavour, and La Tour.	Very severe at Pignerol, and rather so at the three other places.		Preceded, at Pignerol, by three explosions apparently coming from Lucerne.	Ditto.
— — — 10h 30m P.M.	Pignerol	Very severe			Ditto.
— — 6. 1h 30m A.M.	Ivrée	Rather severe. Lasted 10 or 12 seconds.			Ditto.
— — — 2 A.M.	Briquerasque	Slight			Ditto.
— — — Between 2 and 3 A.M	Barga	Ditto			Ditto.
— — — 4 A.M.	Briquerasque and Pignerol.	Severe at Briquerasque; more so at Pignerol than the shock of the night before.		At La Tour dull rumbling noises were heard towards the evening, which continued the whole night and following day.	Ditto.
— — 7. 2h 20m A.M.	La Tour	Moderate		Preceded by a kind of hissing sound, and followed by a rumbling noise about half an hour after.	Ditto.
— — — 2h 30m A.M.	Barga and Briquerasque	Slight shocks at Barga; at Briquerasque but one was felt.			Ditto.
— — — At noon.	Briquerasque	Another slight shock			Ditto.

At dawn.		tible shocks.			
— — — About 3 and 4 A.M.	Ditto	Some slight tremblings.			Ditto.
— — — In the evening.	Ditto	Slight undulations		Accompanied by a rumbling noise, and explosions as of cannon underground.	Ditto.
— — 9. 2 A.M.	Barga	Slight shocks			Ditto.
— — — 3 A.M.	Ditto, and at Pignerol and Briquerasque.	Ditto at Barga. At Briquerasque the motion was scarcely sensible, but at Pignerol it was very severe. There had been slight shocks at the latter place for some days before.			Ditto.
— — — 3h 30m A.M.	Briquerasque and La Tour.	Motion scarcely perceptible at Briquerasque. At La Tour the shock was slight and lasted 4 or 5 seconds.		Three loud explosions were heard at La Tour between 1h 30m and 3h 30m A.M.	Ditto.
— — 10. After midnight of the 9th.	Briquerasque	Some slight shocks			Ditto.
— — — Between 1 and 3 A.M.	La Tour	Two more slight shocks.			Ditto.
— — — 11 P.M.	Ditto	Slight movements five times within an hour.		At Barga some slight rumbling noise was felt on this day, but no shock.	Ditto.
— — 11. 1h 30m A.M.	Pignerol	Slight. Similar shocks on the preceding days.			Ditto.
— — — 6 P.M.	La Tour. Also at Briquerasque.	Moderate at La Tour. At Briquerasque slight shocks had been frequently felt		Rumbling noises had commenced at La Tour between 3 and 4 A.M., and recurred frequently during the day. Two, very loud, were heard at 3h 30m and 10h 30m P.M. The noises re-	Ditto.

1.	2.	3.	4.	5.	6.
		from midnight until the morning of this day, especially towards the mountains. They recurred at the hour heregiven, and more feebly at 9 P.M.		curred like explosions the next morning at 6 A.M., and were frequently heard during the day.	
1808. May 13. $2^h 45^m$ A.M.	Pignerol	Very severe. Several others, feebler, during the day.			Vassali-Eandi's Account, &c.
——— Between $2^h 30^m$ and $3^h 30^m$ A.M.	La Tour	Two very perceptible shocks.		All was quiet at this place during the remainder of the day, until 10 P.M., when an explosion was heard.	Ditto.
——— 11 A.M.	Pignerol	Another shock, similar to that of $2^h 45^m$.			Ditto.
——— 14. $2^h 15^m$ A.M.	Ditto	Very perceptible			Ditto.
——— $4^h 15^m$ A.M.	Ditto	Ditto. Both this and the last shock lasted rather a long time.		Accompanied, as was the last shock, by a prolonged noise.	Ditto.
——— $4^h 30^m$ A.M.	La Tour	Slight		Accompanied by rather a loud noise. At 2 A.M. a subterranean explosion.	Ditto.
——— $3^h 40^m$ P.M.	Ditto	Slighter than the last.			Ditto.
——— 15. At night.	Briquerasque	Undulatory motion lasting several hours.		At La Tour a single explosion was heard during the night.	Ditto.
——— 16. 6 A.M.	The country lying along the river Pelice.			A red cloud hung over the river and the surrounding district; at the moment of the shock there was an odour of sulphur, and altogether became imperceptible four minutes afterwards.	Ditto.
——— 17. 4 A.M.	Briquerasque	Very slight. Undulatory movements were also felt.		Buildings continued to suffer damage. Those which had been already propped up, had now to be still more strongly supported, in order to prevent their destruction. The catalogue of these shocks by M. Vassali-Eandi, from which most of the preceding facts are taken, terminates at this date.	Ditto.

8 A.M.				carriage.	
—— —— 25. About 11 A.M.	Montalto-di-Chieri, la Stura, Italy.	Shocks		During a dreadful tempest	Ditto, 15 Juillet.
—— In summer.	In Iceland	A severe earthquake		A new hot spring made its appearance, and others ceased to flow for fifteen days.	Eyriès, Abrégé des Voyages modernes, t. vii. pp. 51 et 273.
—— July 1.	Turin	Two slight shocks			Journ. des Débats et Moniteur, 18 Juillet.
—— August.	At Mount Etna	Several shocks		Accompanied by explosions	Ann. de Chim. et de Phys. *loc. cit.*
—— Sept. 26. 3h 15m P.M.	Pignerol	Another slight shock, which seemed to come from the S.E.			Journ. des Débats et Moniteur, 14 Octobre.
—— —— ...	Mount Etna	Several shocks during the month.		Ditto	Ann. de Chim. et de Phys. *loc. cit.*
—— Oct. 22.	Pignerol	Three more shocks			Journ. des Débats, 5 Nov.
—— —— 26. From 8 to 11 A.M.	Leghorn	Several shocks		Some chimnies were thrown down by one of the shocks.	Journ. des Débats et Moniteur, 13 Nov.
—— Nov. 22. 7h 40m A.M.	Pignerol	A rather severe shock.		M. Perrey seems to think that the shocks at this place in September, October and November, present some indication of periodicity.	Journ. des Débats, 5 Déc.
—— Dec. ... Night between 20 and 21.	Marche in the departm. Sambre-et-Meuse.	A shock of 2 or 3 secs. duration.		During the night of the 12th of this month a number of avalanches in Switzerland—an earthquake *suspected*. (Journ. des Débats, 9, et Moniteur, 10 Janv. 1809.)	Ditto, 4 Janv. 1809.
—— —— ...	Janina in Epirus	Shocks on one day during the month.			M. Pouqueville, *loc. cit.*
—— —— ...	Mount Etna	Several shocks during the month.		Accompanied by explosive noises	Ann. de Chim. et de Phys. *loc. cit.*
1809. Jan. 15.	Kionkable in West Gothland, Sweden.	One shock		No damage done. Keilhau, quoting Keferstein, gives the date Jan. 19.	Moniteur, 1 Avril, 1809.
—— —— 18. 2 A.M.	Dunning in Perthshire	Direction = N.W. to S.E.		Preceded and succeeded by a loud subterranean noise like thunder, lasting altogether about a minute. The atmosphere was calm, dense, and cloudy. The thermometer at 17° Fahr.	Tilloch's Magazine, vol. xxxiii. p. 91.
—— —— 30. At night.	Courtrai	A slight shock		During a terrible tempest	Moniteur, 5 Févr.
—— —— ...	Janina in Epirus	Shocks felt on one day during this month.			Pouqueville, *loc. cit.*

1.	2.	3.	4.	5.	6.
1809. Jan. ...	Mount Etna	Shocks during the month.			Ann. de Chim. et de Phys. *loc. cit.*
—— Feb. 15.	Grenoble	One shock			Journ. des Débats, 20 Fév.
—— —— ... Night between 16 and 17.	San Germano (where?) in Italy.	A shock of sufficient violence to make the inhabitants quit the town.			Ditto, 11 Mars; Moniteur, 12 Mars.
—— —— ...	Mount Etna	Earthquake again during this month.			Ann. de Chim. et de Phys. *loc. cit.*
—— Mar. 13. $6^h 50^m$ A.M.	Pignerol and its neighbourhood.	Another shock		Preceded by a loud explosion	Journ. des Débats, 25 Mars.
—— —— 20.	Ditto	Ditto			Ditto, 31 Mars.
—— —— 27.	Mount Etna	Another earthquake, the most violent of the year.		Accompanied by eruption of the volcano	Ann. de Chim. et de Phys. *loc. cit.*
—— April 26. 9 P.M.	Berne	A feeble vibration			Catalogue of M. Studer.
—— —— 30.	Cavour, in the arrond. Pignerol.	A violent shock			Moniteur, 13 Mai.
—— ——	Etna				Ann. de Chim. et de Phys. *loc. cit.*
—— May 3, 4 and 5.	Island of Corfu	Many shocks		Houses were injured	Moniteur, 25 Mai et 19 Juin; Journ. des Débats, 18 Juin.
—— —— 8.	At Naples	A shock		During a violent storm. Vesuvius was in eruption.	Moniteur, 25 Mai et 19 Juin.
—— —— ...	Janina in Epirus	*Three* days during the month marked by shocks.		Perhaps the days on which the shocks were felt in Corfu.	Pouqueville, *loc. cit.*
—— —— ...	Etna				Ann. de Chim. et de Phys. *loc. cit.*
—— June 26.	Pignerol	Another shock			Journ. des Débats, 11 Juillet.
—— —— 29.	Thun, and in the Simmenthal, Switzerland.	Vibratory			M. Studer's Catalogue.
—— July 2. $2^h 30^m$ and $5^h 30^m$ A.M.	Dusseldorf and the neighbourhood.	Two shocks		Accompanied by a noise like that of carriages. Cattle bellowed in their stalls.	Journ. des Débats, 9 et 11 Juillet.
—— —— ——	Suze in France	Slight shocks			Ditto.
—— —— 3.	Pignerol	Two severe shocks ...	On the 4th an extraordinary flux and reflux of the sea was observed at		Ditto, 11, 17 Juillet et 4, 10 Août; Moniteur, 18 Juillet et 11 Août.

			noese territory, occurring at intervals of ¼, ½, or 1 hour. A similar phænomenon near Lisbon on the same day, and at Naples on the 27th of the month (*terremoto di mare*).		
1809. Aug. 1.	In the Abruzza Ulteriora, at Aquila.	A severe shock, followed by twenty others before the following day. Undulatory motion continued at least up to the 5th.	....	Some springs appeared to boil up	Journ. des Débats, 21 Août et 2 Sept.; Moniteur, 24 Août et 3 Sept.
—— —— 24. 1 P.M.	Teramo in the same district.	One shock	....	....	Journ. des Débats, 8 et 10 Sept.; Moniteur, 9, 12 et 19 Sept.
—— —— 25. Some min. after 1 P.M.	Macerata in the same region.	A violent shock of 8 or 10 secs. duration.	....	Houses were injured	Ditto.
—— —— ...	Janina in Epirus	Earthquake on one day of the month.	....	....	Pouqueville, *loc. cit.*
—— Sept. ...	Etna	....	....	....	Ann. de Chim. et de Phys. *loc. cit.*
—— Oct. 26. 9h 50m P.M.	Lisbon	A rather violent shock.	....	....	Moniteur, 2 Déc.
—— Nov. 23. Between 2 and 3 A.M.	Copenhagen	A slight shock........	....	....	Ditto, 11 Déc.
—— Dec. 4. 10 P.M.	Cape Town, Cape of Good Hope.	Three shocks from N. to S.; followed, after an interval of ten minutes, by one more. The second shock was by far the most violent.	A heavy swell came into Table Bay after the shocks.	Accompanied by noises like the firing of several pieces of heavy artillery in quick succession, followed by a low rumbling. Immediately after the shock the wind changed from S.S.E. to N.N.W., and then ceased altogether. The sky became clear, and numerous meteors were observed.	Philosophical Magazine (continuation of Tilloch's Magazine), vol. ix. p. 72.
—— —— 5. 7 A.M.	Ditto	Another shock	....	Accompanied, as before, by a noise like thunder.	Ditto.
—— —— —— 12h 30m noon.	Ditto	Ditto	....	Ditto	Ditto.

1.	2.	3.	4.	5.	6.
1809. Dec. 5. A little before 5 P.M.	Cape Town, Cape of Good Hope.	Slight oscillation	....	Accompanied by a low rumbling noise. Very many people asserted that they felt the shocks on the bursting of the meteors, which were very brilliant, and seen by all. On the morning of the 5th, in Blauweberg's valley, several fissures opened in the earth, *some of them nearly a mile in length*, and varying in depth from 3 to 10 feet, and in breadth from 1 to 5 inches. Muddy water was thrown up to the height of 6 feet from some small holes which opened in the sandy soil of this place.	Philosophical Magazine (continuation of Tilloch's Magazine), vol. ix. p. 72.
—— —— ...	Etna..............	....	....	....	Ann. de Chim. et de Phys. *loc. cit.*
1810. Jan. 14. 5h 53m P.M.	Vienna..............	Two shocks, separated by an interval of some seconds.	....	Accompanied by a cracking noise. The ice of the Danube was broken. An astronomical clock was stopped, the pendulum of which did *not* move in the direction N.E. to S.W. Others, oscillating in this direction, were not affected.	Journ. des Débats, 30 et 31 Janv., 13 Fév.; Moniteur, 29 Janv., 1 et 15 Fév.
—— —— —— 6h 45m and 7h 10m P.M.	In Hungary; the centre of disturbance was apparently the mountain Czoka.	The earth trembled violently. At Czacbereng the shocks were very intense; 177 were felt up to the 19th.	....	At Mount Czoka subterranean bellowings had been heard for eight days. Many buildings were thrown down, and several springs of mineral water made their appearance.	Ditto.
—— —— 21.	Komarom (Komorn?) in Hungary.	Another earthquake ..	....	....	Férussac, Bull. des Sciences Nat. t. xviii. p. 195.
—— —— 22. 10 A.M.	Pignerol, La Tour, and Lucerne.	Another shock	....	Accompanied by an explosion. M. Perrey remarks that this is another instance of the periodical recurrence of the shocks of the district of Pignerol on the 22nd of the month.	Journ. des Débats, 4 Fév.
—— Feb. 3. At dawn.	Czakwar in the territory of Stuhlweissenburg, Hungary.	Some shocks as violent as those of the 14th Jan.	....	Houses situated on a mountain were observed to be lighted up after the shocks; it was supposed by the reflexion of subterranean fire from some opening in the earth caused by the earthquake (!) (?).	Ditto, 13 Mars.
—— —— 16. 10h 15m P.M.	Trieste	A rather violent shock.	....	....	Ann. de Chim. et de Phys. *loc. cit.*; Journ. des Débats, 28 Fév., 6 et 14 Mars; Moniteur, 2 Mars.
—— —— —— 10h 55m P.M.	Naples and Otranto ...	At Naples a shock lasting nearly a	....	Vesuvius was tranquil, but loud noises were heard at Etna, and *four* earthquakes ensued.	Journ. des Débats et Moniteur, *loc. cit.*

[illegible]	[illegible]	minute. At Otranto its violence was terrible; the inhabitants spent the night out of doors.		of which one was felt in Malta, in Africa (that here recorded), and even in the island of Cyprus.	
1810. Feb. 16. At night (probably about same time as at Naples).	Malta	The most violent shock felt up to that time in Malta. Lasted two minutes.			Moniteur, 2 Mai; Gentleman's Magazine, vol. lxxx. p. 371.
—— Nearly at same time with last event.	The town of Candia, in the island of same name.	A violent earthquake.		The city was ruined, and 2000 persons perished.	Huot, Géologie; Journ. des Débats, 19 Mai ("sous la rubrique de Candie, 26 Mars").
—— —— 17. 2h 15m A.M.	Naples	Another shock. Direction E. to W.			Journ. des Débats et Moniteur, *loc. cit.*
—— —— —	Malta	Two more shocks, less violent than the former one.			Moniteur, 2 Mai.
—— Mar. 16.	Langres in the departm. of Haute-Marne, and Is-sur-Tille in the Côte-d'Or.	A shock from N. to S.			Journ. des Débats, 23 Mars et 17 Avril; Huot.
—— —— 25.	Island of Teneriffe	A very violent earthquake.		Many people perished beneath the ruins of the houses.	Journ. des Débats, 4 Juin, 1810; Huot, Géologie, t. i. p. 114.
—— —— and even in April.	In Hungary	Some slight shocks still felt, but less frequently than before.			Moniteur, 9 Mai (sous la rubrique de Vienne, 24 Avril).
—— April 8. 7h 25m P.M.	Calcutta and other places in Bengal.	Two shocks from N.E. to S.W., the first lasting 6, and the second 30 secs.			Gentleman's Magazine, vol. lxxx. pt. 2. p. 378.
—— —— 14.	Moor in Hungary	A very severe shock			Journ. des Débats, 22 Mai; Moniteur, 23 Mai.
—— —— ...	Janina in Epirus				Pouqueville, *loc. cit.*
—— May 15.	Moor in Hungary	Two more shocks of great severity.			Journ. des Débats et Moniteur, 5 et 6 Juin.
—— June. ... Beginning of the month.	Ditto	Another shock			Moniteur, 7 Juillet.

1.	2.	3.	4.	5.	6.
1810. June 25.	In East Gothland, Sweden.	A vibration lasting one second.			Moniteur, 31 Juillet; Journ. de l'Empire, 30 Juillet et 14 Août.
—— July 1.	In the neighbourhood of Nischneikamtschatsk, Kamtschatka.	Several shocks			Moniteur, 23 Juillet, 1811.
—— —— 4.	Moor in Hungary	Another shock		Houses were thrown down	Journ. de l'Empire, 10 Août.
—— —— Night between 6 and 7.	Sienna and Arezzo	Two shocks, of sufficient severity to throw down articles of furniture.		A terrible storm at Leghorn on the 7th	Moniteur, 26 Juillet.
—— —— 13.	Moor in Hungary	Another shock			Journ. de l'Empire, 10 Août.
—— —— ... Night between 22 and 23. About midnight.	Lubring in Croatia	A severe shock		Accompanied by subterranean noise like a clap of thunder.	Moniteur, 25 Août.
—— —— 23. At noon.	Ditto	Another shock, less violent.			Ditto.
—— —— 27. 3 A.M.	Hermannstadt in Transylvania.	A very severe shock		Accompanied by subterranean noise	Journ. de l'Empire, 5 Sept.; Moniteur, 6 Sept.
—— —— 28. 6 (A.M.?)	Ditto	Ditto		Ditto	Ditto.
—— —— 29. Noon.	Ditto	Ditto		Ditto	Ditto.
—— —— 30. 4 A.M.	Ditto	Ditto		Ditto	Ditto.
—— —— and in August.	San Miguel in St. Michael's, Azores.	Severe shocks		The commencement of the violent disturbances which this island experienced in 1810–11. The authorities here given apply to both years.	Journ. de l'Empire, 11 Oct. 1810, et 27 Sept. 1811; Webster in Eyriès, Nouv. Ann. des Voy. t. xvii. Janv. 1823, p. 48; v. Humboldt, Voy. aux rég. équin. t. i. pp. 187, 377 et 391. t. v. p. 7; v. Buch.
—— Aug. 11.	Ditto	Ditto. The shocks continued, though but slightly, up to January 1811.		The village of Las Casas, consisting of 22 houses, disappeared, and a lake of boiling sulphurous water appeared in its place. There had been a slight eruption of the Pic de Genctas in the S.W. of the island. The Annual Register gives the date, Aug. 12, noon.	Ditto; Annual Register, vol. liii. p. 89.

1810. Aug. 31. $7^h 58^m$ A.M.	Saumur in France. Also felt in Vendée.	A severe shock. In Vendée it lasted 3 or 4 seconds.		Accompanied by subterranean noise like that of a heavy-laden carriage in rapid motion. On the same day remarkable meteors were observed.	Journ. de l'Empire, 8, 14 et 15 Sept.
—— Sept. 1. $8^h 15^m$ A.M.	Inspruck	A shock, without any oscillation.		Followed soon after by a very loud subterranean noise. It seems however doubtful whether this shock was not the effect of an explosion of gunpowder which took place at Eisenach (at $8^h 45^m$).	Moniteur, 18 et 19 Sept.
—— —— 7. $7^h 45^m$ A.M.	La Rochelle	A shock from S. to N.			Journ. de l'Empire, 16 Sept.
—— —— 10. 7 A.M.	Brest	A severe shock, followed by another during the night.		Accompanied by a noise like that of a large vehicle.	Ditto, 18 Sept.
—— —— 13. $10^h 5^m$ P.M.	Gross-Kanischa in Hungary.	Rather violent shock, from N.E. to S.E.(?)			Ditto, 11 Oct.
—— ——	Janina in Epirus	Second and last earthquake during the year.			Pouqueville, *loc. cit.*
—— Oct. Beginning of the month.	Mercatello in the district of Urbino, Italy.	Twenty-six shocks, of which five were very disastrous.			Journ. de l'Empire, 20 Oct.
—— —— 24.	Reykiavik and around Mount Hecla, Iceland.	An earthquake			v. Hoff, Th. 2. S. 388.
—— —— ...	In Norway and in Germany.				Ditto.
—— Nov. 2.	Lisbon	A slight shock			Moniteur, 28 Nov.
—— —— 9. About $9^h 3^m$ P.M. ($9^h 30^m$ at Portland — probably an error.)	Portsmouth (N. Hampshire?) in the United States. Also felt at Kennebunk, Portland, Salem, Newburgh-Port, York, Exeter, Dover, Haverhill, and several other towns.	At Portsmouth a violent vibratory shock from N.W. to S.E., lasting one or two minutes. At Kennebunk there were several shocks during about 20 secs. At Portland but a slight vibration.	The shock was felt on board a vessel entering the harbour of Portsmouth; it was supposed that she had touched the bottom.	At Portsmouth followed by a pretty loud explosion. Windows were broken. At Kennebunk also loud detonations were heard, and the houses were violently shaken. At Portland there was a perfect calm until a moment before the shock, when a violent wind suddenly rose.	Ditto, 18 Janv. 1811.
—— —— 29. 11 A.M.	At sea, to the south of Cape Matapan, Greece.	A violent shock, which lasted a minute and a half.			Férussac, Bull. des Sc. Nat. t. viii. Sept. 1827, p. 51.

1.	2.	3.	4.	5.	6.
1810. Dec. 25. 2 A.M.	Turin and Parma. Also at Reggio, Verona, Venice, Florence, &c., but not everywhere at the same hour.	At Turin a rather severe shock; at Parma a violent one, followed immediately after by violent oscillations from E. to W., lasting nearly a minute.	....	At Parma a sudden light was observed, followed by an explosion like a loud clap of thunder.	Journ. de l'Empire, 2 et 4 Janv.; Moniteur, 3, 8 et 9 Janv. 1811.
—— —— ... Night between 26 and 27.	Genoa	Some shocks *supposed* to have been felt.	....	In the midst of a terrible storm	Ditto.
1811. Jan. 1. 8h 20m (A.M. or P.M.?)	Tiflis in Georgia	Two consecutive shocks from S. to N.	....	....	Journ. de l'Empire, 21 Avril.
—— —— 28, 30, and 31.	St. Michael's, Azores ...	The shocks, which had been but slight since August, were now very violent, especially on the 31st.	....	On the 31st the town of Porta Delgada was violently shaken by the earthquake. On the 1st of February a violent submarine eruption commenced at about two miles from the west coast; smoke, ashes, pieces of lava, and other ignited materials were thrown up in a column visible from the coast. The eruption lasted eight days, and produced a bank over which the sea broke. The phænomena recommenced in June following.	Webster and v. Humboldt, *loc. cit.*
—— Feb. 1. 11 P.M.	St. Jean-de-Maurienne..	Two slight shocks ...	....	....	Journ. de l'Empire, 18 Fév.; Moniteur, 17 Fév.
—— —— 18. At night.	Rome, Frascati, Tivoli, &c.	A violent shock	....	....	Journ. de l'Empire, 5 Mars; Moniteur, 4 Mars.
—— March.	Etna. A shock on the 27th was felt throughout the whole island.	A great number of slight earthquakes during the month.	....	....	Ann. de Chim. et de Phys. *loc. cit.*
—— —— ...	Janina in Epirus.........	An earthquake	....	....	Pouqueville, *loc. cit.*
—— April 13.	Pignerol	One shock	....	....	Moniteur, 30 Avril.
—— —— 14.	Ditto	Two other shocks, separated by an interval of 12 hours.	....	....	Ditto.
—— —— 21.	Moor and Escawar in Hungary.	Violent shocks	....	....	Ditto, 25 Mai.

1811. May. Beginning of the month; lasting until the 12th.	Island of St. Vincent in the West Indies.	Many shocks. In the Antilles more than two hundred were reckoned from this time up to April 1812.			v. Humboldt, Personal Narrative, vol. iv. p. 36, and Voyages, t. v. pp. 5–14.
—— —— 19.	Constantinople	Some shocks from S. to N.		Attended with subterranean noise	Moniteur, 7 Juillet; Journ. de l'Empire, 8 Juillet.
—— —— 21.	Ditto	Ditto		Ditto	Ditto.
—— —— 24.	Ditto	Ditto		Ditto	Ditto.
—— —— 29. 10 P.M.	Rome, Frascati, Tivoli, &c.	A rather violent shock			Journ. de l'Empire, 13 Juin; Moniteur, 14 Juin.
—— June 1. 3 A.M.	Plymouth		At the hour mentioned, the sea suddenly retired, leaving the shipping dry, and in half an hour after, a wave of 10 or 11 feet in height came in with great violence. This recurred twice, though with diminished violence.	Accompanied by a tremendous noise and violent gusts of wind from the S.W. The mercury in the thermometer (barometer?) rose and fell tremulously during the rushing in of the wave.	Annual Register, 1811, p. 61.
—— —— 13.	St. Michael's, Azores	Severe and repeated shocks. During the eruption the ground on the island was in a continual state of vibration, varying in intensity with the eruption. The phænomena continued with great violence for four days, but had so much abated on the 4th of July that people were able to land on the volcanic island which had been formed.		The submarine eruption of February now recommenced at two miles and a half further from the coast than before. A mass of rock was detached, by the motion, from the coast of St. Michael's and fell into the sea. For an account of the details of the eruption, which was of great violence, and accompanied by a constant noise like a heavy and well-sustained fire of artillery and musketry, vide the authorities quoted above.	Webster and v. Humboldt, *loc. cit.*

1.	2.	3.	4.	5.	6.
1811. July 4.	In Lapland	An earthquake		A volcanic eruption on this day from a mountain in the most northern part of Norway. (This is considered doubtful by Keilhau.)	Keferstein; Moniteur, 9 et 21 Janv. 1812.
—— —— 7.	In Norway	Ditto			Keilhau, *loc. cit.*
—— —— 15. 11h 44m P.M.	Genoa	A shock of short duration, but rather violent.		The heat for three days before had been suffocating.	Journ. de l'Empire, 27 et 29 Juillet; Moniteur, 28 Juillet.
—— —— 16. At night.	Leghorn	A severe shock			Ditto.
—— —— 29. 8h 26m A.M.	Verona	A slight shock, lasting three seconds. This was the second felt during the preceding month.			Moniteur, 21 Août.
—— Aug. 1. About 8 P.M.	Reggio in the Duchy of Modena.	A rather violent shock. A slight one had been felt nearly a month before.			Ditto, 5 Sept.
—— —— 5.	In Lapland	Another earthquake		Another eruption on this day in the north of Norway, doubted as before by Keilhau.	Keferstein; Moniteur, 9 et 21 Janv. 1812.
—— —— ...	Janina in Epirus	One earthquake during the month.			Pouqueville, *loc. cit.*
—— Sept. 10.	In Lapland	Another earthquake		Ditto	Keferstein; Moniteur, 9 et 21 Janv. 1812.
—— —— ...	Janina in Epirus	One earthquake during the month.			Pouqueville, *loc. cit.*
—— Oct. 4. 9h 5m A.M.	Vienna. Also felt in Upper Styria and Carinthia.	At Vienna a slight shock of three seconds' duration. In Styria and Carinthia two very violent shocks, from S.E. to N.W.		The clocks of the Observatory at Vienna were not stopped. At Kriegbach some chimnies were thrown to the S.E.	Journ. de l'Empire, 18 et 19 Oct.; Moniteur, 17, 20 et 21 Oct.
—— —— ...	Messina	Several shocks during the month. The most violent was on the 27th.		Etna was in eruption	Journ. de l'Empire, 28 Nov. et 28 Déc.; Moniteur, 27 Déc.
—— Nov. 17. 5h 30m (A.M.	Muzzuschlag in Styria	Several shocks, each lasting half a se-		The weather was hazy. No noise was observed.	Moniteur, 7 Déc.

or P.M.?).		cond, but less violent than those of the 4th of October. Apparent direction W. to E.			
1811. Nov. 25 to Dec. 10.	In the Grisons, Switzerland.	Many shocks during this period.	....	....	Ditto, 27 Déc.
——— 31. 2h 40m A.M.	Portsmouth, Gosport, &c.	Lasted nearly a minute.	....	....	Annual Register, 1811, p. 135.
— Dec. 12. 8h 30m P.M.	Marienberg, Annaberg, Elbogen, Saatz, Kaden, &c., on the N.W. frontier of Bohemia.	At Marienberg and in the mountains of Saxony two violent shocks. At Hauenstein the direction of motion was S. to N. At Annaberg it was S.E. to N.W. At Kaden, Elbogen, and Saatz the shock lasted a minute.	....	Accompanied at Marienberg by a noise like that of some enormous chariot. At Hauenstein, and Saatz, &c., noise like thunder was heard. The barometer at Prague had suddenly, on the 10th, fallen below its mean level. The event is reported on the 13th at Kaden, but doubtless through error.	Gentleman's Magazine, vol. lxxxii. pt. 1. p. 77; Journ. de l'Empire et Moniteur, 28 Déc. 1811, 1 et 7 Janv. 1812.
——— 16. At Nashville (Tennessee), 2h 15m A.M. At Pensacola (Florida), from 1h 30m to 6 A.M. At Charleston (S.Carolina), 3 A.M. At St. Louis (Missouri), about 2h, 2h 47m, 3h 34m, a little after sunrise, about 8, 11h 30m A.M. At Vincennes (Indiana), about 3 A.M.	Valleys of the Mississippi, Ohio, and Arkansas. Principally in the state of Ohio, but felt also at places in Tennessee, Kentucky, Missouri, Indiana, Virginia, N. and S. Carolina, Georgia, and Florida. The shocks were feebler to the east of the Alleghanies than to the west, and were not felt in the swampy region of Louisiana about the mouth of the Mississippi. About New Madrid, in lat. 37° 45′, they continued daily, almost hourly, for months, but these	The disturbance of this region now commenced, which lasted until 1813. The shocks began at various places at the hours mentioned in Column 1, and recurred at some for two or three days, at others for a long time after. At most of these places, however, there were several shocks during this first night. At Charleston there were six quite distinct. General direction E. to W., not uniform. The	....	These shocks were accompanied in general by loud subterranean noise, apparently coming from the S.W. At Nashville some chimnies were thrown down. The atmosphere there was dull and heavy. At Pensacola the houses were heard to crack, and doors and window-shutters seen to move. At Charleston the bells rang. In Missouri (*according to the Indians*) trees were thrown down, and rocks split. At St. Louis a loud subterranean noise like thunder was heard; it seemed to come from the N. or N.W. There was not a breath of wind, and the sky was obscured by a thick fog. The heat was very great for the season. At Vincennes chimnies were cracked. At Cincinnati furniture was displaced, doors opened, and bricks thrown down from the chimnies. At Dalton no sound was heard accompanying the shock. At Zainenville, Springfield, &c., trees and other elevated objects received a distinct undulatory motion. Clocks were stop-	v. Humboldt, Personal Narrative, vol. iv. p. 36; Relation Historique, t. v. p. 9; Trans. of the Liter. and Philos. Soc. of New York, vol. i. p. 281; Drake, Nat. and Stat. View of Cincinnati, p. 232; Silliman's Journal, vol. i. p. 93; Moniteur, 9 Mars et 14 Oct.; Journ. de l'Empire, 15 Oct. 1812, &c.

1.	2.	3.	4.	5.	6.
At Cincinnati, $2^h\ 20^m$ A.M., less than half an hour after, $7^h\ 20^m$, and between 10 & 11 A.M. At Dalton (Ohio), between 2 and 3 A.M. At Zainenville, Springfield, and the neighbourhood (Ohio), about 3 A.M., 8^h, $8^h\ 10^m$, $10^h\ 40^m$, and 25^m past noon.	long-continued shocks were for the most part very slight.	first was the most violent, and lasted a minute. At St. Louis there were shocks lasting 1¾, 2, 1, ½ min., and 50 secs. At Vincennes there were three shocks, followed by a fourth at sunrise, and several others during the day. At Cincinnati the motion seemed to commence on the 15th about 11 P.M. The most violent shock, at $2^h\ 20^m$ A.M. on the 16th, lasted five minutes, according to some, and but two, according to others. The others felt here were of shorter duration, and feebler. At Dalton the motion was almost continuous for two days. At Zainenville, Springfield, &c., where the direction N.E. to S.W., there were several shocks next day.		ped at these places. The air was quite calm, and no noise was heard. During these shocks great clefts opened in the ground, from which quantities of water, sand, and pieces of coal were thrown out. Large lakes were formed in many places. The level of the ground was permanently raised and depressed in various localities, and a bar thrown up across the Mississippi. Trees were *seen* to bend before the shocks, and were often locked together so that their branches were torn and broken. For further details see the authorities quoted.	
1811. Dec. 18. $11^h\ 55^m$ P.M.	Verona........................	A shock of 3 seconds' duration. The *fourth* earthquake in the year.	....	A thick fog prevailed at the time, but soon after the earthquake the lamps gave light as usual (in the streets?).	Journ. de l'Empire, 3 Janv.; Moniteur, 9 Janv. 1812.

1811. Dec. 18.	Caraccas	A single shock, after which nothing was felt here until the terrible earthquake of March 26 following.		The weather was calm and serene	v. Humboldt, Personal Narrative, vol. iv. p. 36; Voyages, t. v. p. 5.
1812. Jan. 6.	In the valley of the Missisippi, especially at New Madrid. It extended 200 miles from this place (in every direction?).	A violent earthquake. The ground had been constantly agitated, as mentioned above, for a month before, and continued so until the date of the Caraccas earthquake.		The town of New Madrid was greatly injured	Silliman's Journal, vol. iii. p. 20; Huot, Géologie, t. i. p. 114.
—— —— 17. 8h 10m P.M.	In the province of Södermanland, Sweden.	Two shocks. The first was rather feeble, and was followed, after an interval of a minute, by the second, of greater violence and lasting 15 seconds. (Five or six undulations were counted per second.)		The weather was calm, and the sky cloudless, but the earth was enveloped in a thick mist. The barometer varied frequently during the phænomenon.	Moniteur, 15 et 28 Fév.; Journ. de l'Empire, 16 Fév.
—— —— 18.	In Oxfordshire	Trembling lasting ten minutes.		Attended by a heavy rumbling noise	Gentleman's Magazine, vol. lxxxii. pt. 1. p. 80.
—— —— 23. 8h 30m A.M.	New Orleans, and still more at Pensacola.	A slight vibration which lasted but a few seconds.		The weather was fine, and the air calm, or at most there was a very gentle breeze.	v. Humboldt, *loc. cit.*; Moniteur.
—— —— 26. 10h 40m P.M.	Genoa	A shock of 2 or 3 seconds' duration.			Journ. de l'Empire, 11 Fév.
—— —— 27. 4h 50m P.M.	Ditto	A second shock, of greater violence but shorter duration.			Ditto.
—— —— …	Janina in Epirus	One earthquake during the month.			Pouqueville, *loc. cit.*
—— Feb. 1. 9h 15m A.M.	At the salt-works of Ischl, in the neighbourhood of Lintz.	A rather severe shock.		A building was cracked by the shock	Moniteur, 9 Mars.

1.	2.	3.	4.	5.	6.
1812. Feb. 3. 7h 15m A.M.	Macerata in the States of the Church.	A shock in the direction of the N.W. (from S.E.?), with a perceptible oscillation for 3 or 4 secs.			Moniteur, 29 Fév.; Journ. de l'Empire, 1 Mars.
—— —— 4. In the afternoon.	Ditto	Perceptible shocks			Ditto.
—— —— 7. 10h 15m P.M.	New Orleans, and still more at Fort St. Stephen.	A slight oscillatory motion like that of a ship when getting under weigh. It recurred twice or thrice in two minutes. During this day and the following there was continual oscillation in the basin of the Mississippi.		The year before these repeated shocks on the Mississippi, it had been remarked that Louisiana was almost quite exempt from storms.	v. Humboldt, *loc. cit.*; Moniteur.
—— —— 9. 9 A.M.	East Haddam, Connecticut.	Two of the slight rumblings so often felt or heard here.		The weather was clear	Silliman's Journal, vol. xxxix. p.339.
—— —— ... Night between 11 and 12.	Macerata in the States of the Church, and at San-Severino.	Two shocks, more severe at San-Severino than at Macerata.			Moniteur, 29 Fév.; Journ. de l'Empire, 1 Mars.
—— —— 14. 10h 45m A.M.	Mirabel in the departm. Drôme.				Journ. de l'Empire, 25 Mars.
—— —— 15. 2h 30m A.M.	Ditto	Another shock			Ditto.
—— —— — 8h 15m A.M.	Ditto	Another, the most violent of the three.		Some pieces of rock were detached from a cliff.	Ditto.
—— —— 19. 4 A.M.	In the Brettigan (Grisons).	Several shocks			Moniteur, 23 Mars; M. Studer's Catalogue.
—— Mar. 19. Midnight. At Marseilles half an hour after	Beaumont, Vaucluse, Avignon, Apt, and the southern part of the department Vaucluse.	At Beaumont several shocks. At Marseilles a single one. At the former place		Much damage was done to buildings, for the repair of which Napoleon gave 12,000 francs by a decree dated Wilna, 2nd July.	Journ. de l'Empire, 4 Août; Statistique des Bouches-du-Rhône; Guérin.

midnight.	The village of Beaumont seems to have been the centre of disturbance. Also at Marseilles.	the motion continued until April, or according to M. Guérin, until May 30, another shock of note occurring on the 26th March, the day of the Caraccas earthquake.			
1812. Mar. 22. About 3 A.M.	Rome	An undulatory shock, the most severe felt for some time, from W. to E., not from N. to S., as was at first stated. Lasted twenty-five seconds. There had been a slight oscillatory movement at 11h 30m P.M. on the 21st, and a similar one followed at 4 A.M. on the 22nd.	....	Accompanied by a noise like thunder. The atmosphere was calm, and cloudy. Considerable damage was done.	Moniteur, 5 Avril; Journ. de l'Empire, 6, 7 et 8 Avril; Gentleman's Magazine, vol. lxxxii. pt. 1. p. 475.
——— 26. 4h 7m P.M.	Caraccas, and the surrounding country. The earthquake extended over the provinces of Venezuela, Varinas, Maracaibo, and particularly in the high mountains of Merida, in New Grenada, and as far as Carthagena in the Andes; on a line from E.N.E. to W.S.W.	The first shock lasted five or six seconds, and was immediately followed by a second of ten or twelve seconds. Then a movement in a perpendicular direction, followed by rather more prolonged undulation. The shocks were from N. to S. and from E. to W., *and of the greatest violence*. They recommenced on the 27th, and fifteen shocks	Felt on board ships in the port of La Guayra as if they had been on the rocks.	Accompanied by a noise louder than thunder. Caraccas was utterly ruined by this terrible earthquake. The earth at that place appeared like the surface of a boiling liquid. At Valencia an immense torrent of water burst forth, and the lake of Maracaibo was lowered. Large masses of rock were detached and hurled down from the mountains. The sky was clear, and the night calm and beautiful. The preceding day had been extremely hot. Not a drop of rain had fallen for five months. The shocks were more violent in the Cordilleras, of gneiss and mica-slate, than in the plains. They were very slight in the valleys of Aragua between Caraccas and San-Felipe and at Nueva-Barselona; and at Coro, a town situated amongst others which were injured, they were not felt at all. The towns that	v. Humboldt, Voyages, liv. v. ch. 14. et t. v. p. 295; Annual Register, 1812. p. 39; Moniteur, 25, 30 Mai, 4, 30 Juin, 2 Juillet, 8 Août, 28 Sept.; Journ. de l'Empire, 24 Mai, 3 et 9 Juin; Ann. de Chim. et de Phys. t. lii. p. 189, t. lviii. p. 83.

1.	2.	3.	4.	5.	6.
		were felt daily up to the 5th April, when another earthquake occurred nearly as violent as the first.		were ruined are said to have been thrown down like houses of cards. The shocks of the 27th were accompanied by very loud and prolonged noise. On the 5th of April the ground was in a state of undulation for several hours. On the 24th April the first eruption since 1718 of the volcano of St. Vincent commenced. The noise from it was heard at Caraccas and the country about on the 30th, conveyed, as v. Humboldt supposed, through the earth.	
1812. Mar.	Janina in Epirus	One earthquake during the month.			Pouqueville, *loc. cit.*
—— Apr. 4.	At sea, off Caraccas			The vessel trembled as if upon a reef	Tilloch's Magazine, vol. lxvii. p. 149.
—— May 1. $6^h 20^m$ P.M.	In Gloucestershire	Direction W. to E.		Accompanied by a noise like thunder	Gentleman's Magazine, vol. lxxxii. pt. 1. p. 479.
—— —— 2. $6^h 15^m$ A.M.	Potenza in the Basilicata, Italy.	A strong undulatory shock from S. to N., lasting some secs.			Moniteur, 30 Mai.
—— —— — 11 A.M.	Nantes and a large part of the depart. Loire Inférieure.	A shock of two seconds' duration.		Some chimnies, &c. thrown down	Ditto, 14 Mai; Journ. de l'Empire, 15 Mai.
—— —— 13. Between 1 & 2 A.M.	Zulpich near Cologne, extending no further than within a radius of two leagues.	Two shocks, with an interval of a minute. The first was the most severe, and lasted two seconds.		Articles of furniture and some old walls were thrown down.	Journ. de l'Empire et Moniteur, 28 Mai.
—— —— End of this month or begin^s of June.	Judenburg in Styria	An earthquake			Journ. de l'Empire, 16 Juin, 1813.
—— June 5. $10^h 48^m$ P.M.	Meldola, in depart. of Rubicon, Italy.	A slight shock		*As always happens in this district*, no damage was done.	Moniteur, 23 Juin.
—— —— 23.	Marseilles	An earthquake was *supposed*.	The sea retired, leaving the port dry, and rushed in again with extreme violence, inundating the quays. This recurred several times.	The Annual Register gives the date June 24	Ditto, 13 Juillet; Annual Register, 1812, p. 88.

8 A.M.	cut.	rumblings common at this place.			
—— —— 17. 4 A.M.	Kandern and Mulheim in the Upper Brisgau.	A shock apparently from E. to W.	....	Accompanied by subterranean noise. A chimney was thrown down.	Journ. de l'Empire, 4 Août; Moniteur, 1 et 11 Août.
—— —— 23. 8h 45m A.M.	Pignerol	A rather severe shock.	....	Preceded by an explosion like a distant clap of thunder.	Journ. de l'Empire, 4 Août.
—— —— 26. About 9 P.M.	Waradin, Inpenschitz, and Agram, in Croatia.	A single shock	....	....	Moniteur, 1 Sept.
—— —— 27. 2 A.M.	Waradin	Another, more severe.	....	Accompanied by thunder and wind. Some walls were broken.	Ditto.
—— Aug. 22. About 3h 30m A.M.	Bex, and Aigle, in the Canton du Vaud.	Lasted two or three seconds.	....	....	Moniteur, 11 Sept.; Journ. de l'Empire, 12 Sept.
—— Sept. 11.	Florence and its environs.	Several shocks during the day and following night. They were frequent until the 14th.	....	Several houses were injured	Moniteur, 25 Sept.; Journ. de l'Empire, 25 Sept. et 1 Oct.; Annual Register, 1812, p. 114.
—— —— About the middle of the month.	In the island of Ischia...	A slight shock.........	....	The weather was very variable at Naples.........	Moniteur, 19 Oct.
—— Oct. 25. 7h 55m A.M.	In Bavaria and the Tyrol, extending to Treviso in Lombardy. A very large district was shaken.	At Inspruck the shock lasted nearly a minute. At Trente the direction was *to the S. and N.W.* At Treviso the duration of the shock four or five seconds (or, according to the Moniteur, 4 or 5 minutes). In other places *two* shocks were felt.	....	At Rohendorf a bell was caused to toll. At Trente a mountain was cleft, and part fell on the following day. At Treviso several houses were violently shaken.	Moniteur, 8, 11, 16, 18, 21 et 26 Nov.; Journ. de l'Empire, 10, 16, 17 et 25 Nov.
—— Nov. Night between 3 & 4.	At Nuremberg...........	Several shocks.........	....	....	Moniteur, 18 Nov.
—— —— 11. 9 or 10 mins. before 6 A.M.	Kingston in Jamaica ...	A shock of forty seconds' duration.	....	Almost all the houses were injured	Ditto, 26 Janv. 1813.

1.	2.	3.	4.	5.	6.
1812. Nov. 12.	Jamaica	Three shocks, together lasting 30 secs.	The sea was much agitated.	Probably the same as the last account	Gentleman's Magazine, vol. lxxxiii. pt. 1. p. 80.
—— —— 18. 7h 15m A.M.	Bonn on the Rhine	A shock lasting two or three seconds.			Journ. de l'Empire, 25 Nov. et 1 Déc.; Moniteur, 28 Nov.
—— —— —— 7h 30m A.M.	In the neighbourhood of the Siebengebirge, close to Bonn.	Two shocks		Some persons on horseback were thrown	Ditto.
—— Dec. 3. 11h 30m P.M.	Foggia, in the kingdom of Naples.	A rather severe shock.			Journ. de l'Empire, 21 Déc.
—— —— 13. 5 P.M.	Oberhalbstein in the Grisons.	A slight shock			Ditto, 16 Janv. 1813.
—— —— —— 9 P.M.	Ditto	Ditto			Ditto.
—— During the Caraccas earthquake.	Portsmouth	A violent shock			Philos. Magazine, 1825, Jan. p. 70.; Férussac, Bull. des Sc. Nat. t. vi. p. 186.
1813. Jan. 16.	In Sicily	Two vibrations		Accompanied by a strong smell of *ammonia*; during a sudden squall.	Ann. de Chim. et de Phys. *loc. cit.*
—— Feb. Night between 1 & 2.	Bucharest in Wallachia.	Three rather severe shocks. The motion was horizontal, from N.W. to S.E.		Accompanied by loud subterranean noise. Walls were cracked.	Journ. de l'Empire, 13 Mars.
—— Mar. 7.	Macerata in the States of the Church.	A shock lasting four seconds.			Moniteur, 29 Mars; Journ. de l'Empire, 31 Mars.
—— April 1 to 9.	Ancona	Slight shocks daily during this period.			Journ. de l'Empire, 3 Mai; Moniteur, 4 Mai.
—— —— ...	Janina	Earthquakes on *two* days during the month.			Pouqueville in Ann. de Chim. et de Phys. t. xlv. p. 408.
—— May 5. 3 and 9 P.M.	Presburg in Hungary	Two slight shocks at the hours mentioned.			Journ. de l'Empire, 26 Mai; Moniteur, 27 Mai.
—— —— ...	Janina	One earthquake during the month.			Pouqueville, *loc. cit.*
—— June 3. Between 3h & 3h 15m P.M.	Œdenburg in Hungary.	Two rather severe shocks.		During a slight storm	Journ. de l'Empire, 16 Juin; Moniteur, 17 Juin.
—— —— 8.	Judenburg and in Styria,	Ditto		On the 30th June a dreadful tempest raged over	Ditto.

$9^h\ 30^m$ A.M.	and the surrounding district.			all Germany.	
1813. June 19. $9^h\ 30^m$ P.M.	Naples	A slight shock.........	....	Less perceptible on hills than in the plain	Moniteur, 14 et 17 Juillet.
—— July 18. $5^h\ 10^m$ P.M.	Rosas in Catalonia, Spain	A violent earthquake.	A number of strange things were thrown up from the sea-bottom on the shore, amongst others the bones of an enormous whale.	A rumbling noise proceeded from the interior of the earth. Preceded by a terrible storm.	Journ. de l'Empire, 1 Août; Moniteur, 2 Août; Palassou, Mém. pour serv. à l'Hist. Nat. des Pyrénées, p. 272.
—— —— 28.	Kingston, Jamaica	A violent shock of earthquake, but of short duration.	....	Accompanying a dreadful tempest, which began by heavy rain.	Moniteur, 10 Juillet, 1814.
—— —— ...	Janina	Earthquake shocks on *nine* days during the month.	....	....	Pouqueville, *loc. cit.*
—— Aug. 7. At Watsborg $0^h\ 45^m$ A.M. At Laybach 1 A.M.	Watsborg in Carinthia. Also felt at Laybach and in Styria.	At Watsborg several shocks, lasting eight or ten seconds. Direction N.W. to S.E. At Laybach three shocks, one of which lasted more than 3 secs. The motion was oscillatory at Brunnsee.	....	Preceded at Watsborg by a dreadful tempest at 7 P.M. the evening before. More strongly felt on the mountains than in the plain. At Laybach the shock of three seconds was accompanied by a dull rumbling sound, like the rolling of a carriage in the distance. The day had been very hot, and the evening was very stormy. Heavy rain fell at the moment of the shocks.	Moniteur, 21 Août, 1 et 8 Sept.; Journ. de l'Empire, 21 Août et 23 Sept.
—— —— 22.	Irkutsk	Two shocks, together lasting 40 seconds.	....	Preceded by a subterranean noise. The sky was serene; the barometer at 28·5 in., the thermometer at 14° Reaum.	Mém. de l'Acad. Imp. de St. Pétersbourg, t. vi. p. 48.
—— —— ...	Janina	Shocks on *four* days during the month.	....	....	Pouqueville, *loc. cit.*
—— Sept. 6. $8^h\ 33^m$ A.M.	Buda, Pesth, and at Stuhlweissenburg.	A very perceptible shock.	....	Some damage done at Stuhlweissenburg	Moniteur, 8 et 10 Oct.; Journ. de l'Empire, 10 Oct.
—— —— 16. $10^h\ 30^m$ A.M.	Marseilles	Vibratory..............	....	....	Statistique des Bouches-du-Rhône.
—— —— 18. $11^h\ 30^m$ A.M.	Teneriffe	Three shocks, of which the first and principal lasted three-quarters of a minute.	The shock was quite perceptible on board vessels near the island.	The origin seemed to be in the Peak of Teneriffe.	Annual Register, 1813, p. 81; Tilloch's Magazine, vol. xlii. p. 316.

1.	2.	3.	4.	5.	6.
1813. Sept. 21. $8^h 40^m$ A.M.	Imola in the States of the Church.	A strong shock from N.W. to S.E., accompanied by undulatory motion for 10 or 12 seconds.		Buildings were much injured.	Journ. de l'Empire, 5 et 11 Oct.; Moniteur, 12 Oct.
—— —— — $1^h 45^m$ P.M.	Forli	Other slight shocks.			Ditto.
—— —— — 3 P.M.	Ditto			The sun appeared with a pale colour. These shocks did much damage at Faenza.	Ditto.
—— —— 22. $1^h 45^m$ A.M.	Rundess, Marlinsbruck, and in the Lower Engadine, Grisons.	Two successive slight shocks.		During thunder and rain	Moniteur et Journ. de l'Empire, 21 et 22 Oct.
—— —— — $3^h 30^m$ A.M.	The whole valley of Coire, Grisons.	An earthquake			Ditto.
—— —— 24. In the evening.	Stamford, Peterborough, &c.	Lasted two seconds			Gentleman's Magazine, vol. lxxxiii. pt. 2. p. 391.
—— —— ...	Janina	Earthquakes on *three* days during the month.			Pouqueville, *loc. cit.*
—— Oct. 6. $9^h 45^m$ and $10^h 2^m$ A.M.	Forli in the Romagna	Two more slight shocks at the hours mentioned.			Journ. de l'Empire, 18 et 28 Oct. et 5 Nov.
—— —— 8. In the morning.	Ditto	Another shock			Ditto.
—— —— 9. 10 A.M. and 11 P.M.	Ditto	Two more shocks			Ditto.
—— —— ... Night between 16 and 17.	Ditto	Four more shocks. The first was violent and rather long.			Ditto.
—— —— 18.	Ditto	Two more shocks			Ditto.
—— —— ...	Janina	One earthquake during the month.			Pouqueville, *loc. cit.*
—— Dec. 25. 1 A.M.	Pisa	A severe shock		Three blows were struck on the bell of a public clock.	Communication of Signor Pilla to M. Perrey.
—— —— 28. 4 P.M.	East Haddam, Connecticut.	The last of the slight rumblings at this place.		The weather was wet	Silliman's Journal, vol. xxxix. p. 336.

1813. Dec. ...	In Epirus................	An earthquake.........	....	Accompanied by a storm of thunder and lightning, which extended from Janina to the island of Corfu. Sorachovitzas was almost entirely overthrown by the earthquake.	Pouqueville, *loc. cit.* and Voyage en Grèce, t. i. p. 431.
1814. Jan. 21. 7h 35m A.M.	Alençon in the departm. Orne.	A rather strong earthquake shock, consisting *of a triple undulatory motion, from the exterior angles* (of the houses?) to the centre, and lasting nearly a second in the direction E. to W.	....	Accompanied by a low noise like that produced by air bursting thin vessels in which it had been compressed. The magnetic needle inclined towards the centre of the earth (the dip increased?), and the barometer, which had been at "Much Rain," altered seven degrees (tenths?) towards "Change," on the moment. It had snowed all night, but after this earthquake the weather was fine and very calm.	Moniteur, 28 Janv.
——— 23. 7h 15m A.M.	Mans in the departm. Sarthe.	Two shocks, the second of which was very violent.	....	The second shock was accompanied by a very loud explosion. During the night of the 26th of this month, a little island in the Archipelago, known to the Turks as Solomon's Isle, disappeared. The night was calm, with scarcely a breath of wind.	Journ. de l'Empire, 28 Janv.; Moniteur, 28 Mai.
—— Mar. 8. 11h 13m P.M.	Nantes....................	A rather severe shock, lasting 15 or 20 seconds. Direction N. to S.	....	Accompanied by a noise like that of a cart laden with planks. The air was highly charged with electricity; some articles which chanced to be slightly rubbed, yielded sparks. Just before the shock the barometer fell suddenly to "Stormy," and the thermometer rose in a few minutes from −2° to +3°. Thunder and lightning followed the shock, but the serenity of the atmosphere was soon restored.	Moniteur, 16 Mars.
——— 19. 8 P.M.	La Chatre in the departm. Indre.	A violent shock, lasting 12 or 15 secs. Direction S.S.E. to W.N.W. (?)	....	Preceded by two luminous meteors, and accompanied by a noise like that of a vehicle on pavement.	Journ. de l'Empire, 29 Mars.
—— April 3. 3h 45m A.M.	Leghorn and Pisa	At Leghorn a strong undulatory and oscillatory shock, lasting 20 seconds after the noise.	....	Accompanied at Leghorn by a terrible noise, which awakened every one. No damage was done here, but at Pisa some buildings were injured. The atmosphere at the latter place was calm and warm, and the light of the sun appeared dim during the day.	"Notizie estratte da un Giornale manoscritte del Dot. Vivoli," communicated by Signor Pilla to M. Perrey.
——— 8h 30m A.M.	Leghorn	A slighter shock	....	....	Ditto.

1.	2.	3.	4.	5.	6.
1814. Apr. 28. $4^h\ 30^m$ A.M.	Inspruck	Two severe shocks from W. to E.		Several houses were injured	Journ. des Débats, 12 Mai.
—— May 7.	Pesth and Ofen in Hungary.	Several shocks			Moniteur, 1 Juin.
—— —— 10.	Ditto	Ditto			Ditto.
—— —— —	Taganrog on the Sea of Azov.	An earthquake		Near the town a little island, about half-a-werst in circumference, made its appearance, but was afterwards destroyed again by the waves. A violent submarine eruption took place this day at about 2 P.M., on the coast of Kamtschatka.	Dubois de Montpéreux, *loc. cit.* t. v. p. 32; Eyriès, Nouv. Ann. des Voyages, t. xxix. p. 109; D'Aubuisson, Traité de Géog. t. i. p. 427.
—— —— 22. $11^h\ 5^m$ A.M.	Marmande, Aiquillon, and Clairac, in the departm. Lot et Garonne.	A shock from E. to W., lasting 2 seconds.			Moniteur, 7 Juin.
—— —— — $11^h\ 30^m$ A.M.	Oléron, and as far as Jacca in Spain.	A long and violent shock.		Masses of rock were detached from a mountain near Oléron.	Ditto, et 9 Juin; Tilloch's Magazine, vol. xliii. p. 463; Palassou, *loc. cit.*
—— —— ...	In Jamaica	A slight earthquake			Moniteur, 19 Juillet.
—— June ...	Janina	One earthquake during the month.			Pouqueville, *loc. cit.*
—— Sept. 1. At night.	At the parsonage of Saltdalen in Sweden, and the neighbourhood.	An earthquake of greater violence than the one of August 31, 1819.			Rigstiunden for 1819, No. 83; Keilhau.
—— —— 2.	Ditto	Two slighter shocks			Ditto.
—— —— Beginning of the month.	Near Alais in the departm. Gard.	No actual shock mentioned. Perhaps not an earthquake.		Loud explosions like the discharge of artillery were heard at intervals for 24 hours, then a great detonation, followed by the sinking of a part of a field of corn. A peasant felt the ground moving under his feet, and saved himself just before the pit formed. The bottom was of clay with interspersed flints, and contained some water. The size of the opening left was 35 metres in diam. by 13 in depth.	Journ. des Débats, 24 Sept.
—— *Before* Sept. 21.	Comorn in Hungary	Several earthquake shocks during the year.			Moniteur, 21 Sept.
—— Oct. 9. Some minutes past 6 P.M.	Kingston in Jamaica, and its neighbourhood.	A violent vibratory shock.			Ditto, 11 Déc.

1814. Nov. 3.	In Sicily, in the neighbourhood of a mountain named Zonolaro, and of the Tempa-del-Basile.			A sudden eruption of ashes took place on this day from a part of the mountain mentioned. The phænomenon was not preceded by any noise, but was followed by an earthquake (perhaps not on the same day (?)).	Ann. de Chim. et de Phys. t. xxi. p. 400.
—— —— 6. $5^h\ 45^m$ A.M.	At Lyons, and along the whole line from Mâcon to Vienne.	Two severe shocks from W. to E.		Preceded by a loud explosion without any lightning. Much rain fell before and after the shocks. Some houses were thrown down, and boats were dashed against one another.	Journ. des Débats, 14 Nov.
—— —— ...	Janina	Shocks on *three* days during the month.			Pouqueville, *loc. cit.*
——	Troïtsko-Savka and Kiachta in Siberia.	An earthquake similar to that of 1829, but less severe than that of 1792.			Férussac, Bull. des Sciences Naturelles, t. xxi. p. 60.
1815. Jan. ...	Janina	Shocks on one day of this month.			Pouqueville, *loc. cit.*
—— April 9. $1^h\ 30^m$ P.M.	Agen and in the departm. Lot-et-Garonne.	Several shocks			Journ. des Débats, 23 Avril.
—— —— Probably at same time as last.	Toulouse	One shock		During this month an eruption of the greatest violence took place in the island of Sumbawa, in the Eastern Archipelago. The effects were terrible, and extended more or less over the whole of the Moluccas and neighbouring islands.	D'Aubuisson, Géologie, t. i. p. 200.
—— June ...	Janina	One earthquake during the month.			Pouqueville, *loc. cit.*
—— —— ...	Iceland, especially in the northern part, in the district of Æsfus.	Ditto		Earthquakes are said to be of frequent occurrence in the district of Æsfus.	Eyriès, Abrégé des Voyages Modernes, t. vii. p. 173; Voyage en Islande.
—— July 8. About 2 P.M.	In the neighbourhood of Mt. Stati, one of the mountains separating Lombardy and Germany.	Two or three shocks..		Accompanied by a little hail and a north-east wind. Snow fell during the following night.	Bibl. Brit. t. lx. p. 391. (partie "Sciences et Arts").
—— Aug. Beginning of the month.	Florence	A severe shock			Moniteur, 31 Août.
—— Sept. 6.	In Sicily	An earthquake			Ann. de Chim. et de Phys. *loc. cit.*
—— —— Beginning of the month.	Naples	Some slight shocks in the direction S.S.E. (to N.N.W.?).			Moniteur, 9 Oct.

1.	2.	3.	4.	5.	6.
1815. Sept.	Janina	One earthquake during the month.			Pouqueville, *loc. cit.*
—— Oct.	Ditto	Ditto			Ditto.
—— Nov.	Ditto	Shocks on *two* days during this month.			Ditto.
—— Dec.	Ditto	*One* day of this month			Ditto.
1816. Feb. 2. 0h 40m A.M.	Lisbon, and to the distance of 300 leagues to the west. Also felt in Madeira and in Holland.	At Lisbon a severe shock which lasted nearly a whole minute, or, according to others, 1½ or 3 minutes. The oscillations appeared to be from N.E. to S.W., and were followed by others of shorter duration at 6h 45m A.M.	Felt on board a ship 270 leagues W.S.W. from Lisbon (in 34° 15′ N. lat. and 15° 10′ W. long. from Lisbon). The first shock was at 0h 46m A.M. (Lisbon time), and produced the impression that the ship had touched the bottom, the grating motion lasting more than two minutes. A second, of much less intensity, was felt at 6 A.M. (Lisbon time). On board another vessel, 120 leagues to the W.S.W. of Lisbon, strong shocks were felt at 0h 42m, lasting five or six minutes, at 3h 40m, for but two or three seconds, and at 5h 57m (all Lisbon time), for three minutes. Also felt on board an American ship between Madeira and the Azores.	At Lisbon the people quitted their houses. There had been a storm the day before, after which the weather was remarkably calm and sultry until the shock, which was succeeded by heavy rain. A meteor appeared immediately after the first shock. Flocks of birds filled the air, uttering the most discordant cries. The Annual Register gives 0h 55m and 7h A.M. as the hours at Lisbon.	Garnier, Météorol. p. 116; Ann. de Chim. et de Phys. t. xi. p. 323; Journ. des Débats, 27 Fév. 3 et 10 Mars; Moniteur, 10 Mars; Annual Register, 1816, p. 22; Tilloch's Magazine, vol. lxvii. p. 148.

1816. Feb. 7.	At St. Gall in Switzerland.	A vibratory shock			M. Studer's Catalogue.
—— Mar. 1.	Askersund in Sweden				v. Hoff, Th. 2.
—— —— 17. $12^h\ 30^m$ noon.	Sheffield, Nottingham, Doncaster, Lincoln, Derby, &c.	Lasted from 1½ to 2 minutes. Appeared to move from W. to E. at Lincoln, and from N. to S. at Derby.		Accompanied by a noise like that of a rising tempest. Pictures, lustres, and bells were set in motion, and the body of a mangle was moved some feet upon its rollers.	Annual Register, 1816, p. 44; Moniteur, 1 Avril.
—— —— 29. (O. or N.S.?)	In the bailiwick of Minkysk, in the country of the Don Cossacks.	Violent shocks			Moniteur, 29 Juin.
—— April. The last Monday in the month, 2 A.M.	Island of Poulo-Penang	Shocks lasting a long time.	Felt on board vessels at sea, more than 30 leagues from the island.		Garnier, Météorol. p. 117.
—— May 15.	Boltigen in the Simmenthal (Canton of Berne).				M. Studer's Catalogue.
—— July 2.	Lenk and Zweisimmen, in the Simmenthal.				Ditto.
—— —— 5.	Ditto				Ditto.
—— —— ... Night between 27 and 28.	Yverdun in the Canton du Vaud.	Several people *believed* that they felt an earthquake.		From the 27th to the 31st the water of the lake of Neufchatel rose two French inches.	Journ. des Débats, 10 Août.
—— Aug. 7. 4 P.M.	Mount Vesuvius	A violent shock		Followed by an eruption	Ditto, 3 Sept.; Moniteur, 4 Sept.
—— —— 13. $10^h\ 45^m$ or 11 P.M.	Inverness and the country for 100 miles round, including Aberdeen, Perth and other places in the north of Scotland; the centre of disturbance being apparently in Inverness-shire.	N.W. to S.E., lasting from 3 secs. to 1 min. at different places. Followed by another and very slight shock after an interval of half-an-hour.		There had been very fine serene weather before the earthquake, but it was followed by continuous and heavy rain. The spire of the church at Inverness was greatly shaken, and five or six feet of the top of it was twisted round, so that the angles of the octagon (the form of section of the spire) coincided with the middle of the faces of the part below. Doors which were open swung backwards and forwards on their hinges several times. Bells rang. A large sluice-gate to a piece of water, weighing several tons, was thrown up twelve inches, and stones rolling under it kept it so until almost all the water had escaped. The water of Loch Leven and some streams flow-	Annals of Philosophy, vol. viii. p. 368; Tilloch's Magazine, vol. xlviii. p. 150.

1.	2.	3.	4.	5.	6.
				ing from it was rendered unusually muddy. Many people experienced a slight faintness and sickness. Dogs howled, and the birds were scared from their roosting places.	
1816. Sept. 7.	Frascati in the States of the Church.	A slight shock			Moniteur, 27 Sept.
—— —— 9.	Montreal in Canada	A severe shock			Journ. des Débats, 1 Janv. 1817.
—— —— 16.	Ditto	A second shock, of less violence than the former, lasted 30 seconds.			Ditto.
—— Oct. 27. 4h 30m A.M.	In Galicia, Spain	A slight shock, the *third* felt during the year.			Ditto, 28 Nov.
—— Dec. ...	Sciacca in Sicily	Several shocks		Accompanied by subterranean noise	Férussac, Bull. des Sci. Nat. t. iv. p. 8.
—— —— ...	In the district of Grandson, Canton du Vaud.	Two shocks. The second was very violent, especially in the hamlet of Corcellètes.		The second shock was accompanied at the hamlet of Corcellètes by a loud subterranean noise.	Bibl. Univ. de Genève, t. iv. Mars 1817, p. 244.
——	On the island of Pantellaria, and in Sicily.	Shocks from S.W. to N.E., and therefore in the line of the volcanos of this region.			Audot, Roy. de Naples, p. 321.
1817. Jan. 13.	Somewhere in the Gulf-Stream (!).				Tilloch's Magazine, vol. xlix. p. 385.
—— —— 15. 7h 30m P.M.	At Payerne and several villages of the Canton du Vaud.	A violent shock			Journ. des Débats, 25 Janv. et 27 Mars.
—— —— 17. 1 P.M.	Ouches in the valley of Chamouni.	One shock			Ditto; Tilloch's Magazine, vol. xlix. p. 385.
—— —— 19. 5 A.M.	Ditto	Ditto			Ditto.
—— —— 20. 4 A.M.	Ditto	Ditto			Ditto.
—— —— ——	Alcocer in Spain				Tilloch's Magazine, *loc. cit.*
—— —— 23. 9h 55m P.M.	Limoges and Gueret	A slight shock			Journ. des Débats, 6 Fév.

1817. Jan. 27. 11 P.M.	Mansfield in Nottinghamshire, and the surrounding villages.				Gentleman's Magazine, vol. lxxxvii. pt. 1. p. 268.
—— 28. 3 A.M.	Macao in China, and the country around.	Two shocks			Asiatic Journal, vol. iv. p. 302; Garnier, Météorol. p. 118.
—— Feb. 2.	Island of Madeira	A violent shock	Felt also at sea, on board vessels more than 200 leagues from the island.		Ann. de Chim. et de Phys. t. xxx. p. 411; Garnier, Météorol. p. 118.
—— —— 5.	Macao in China, and the country round.	Several slight shocks.			Asiatic Journal, vol. iv. p. 302.
—— —— 11.	Bâle in Switzerland	An earthquake			Mérian.
—— —— —	In the valley of Chamouni.	Another shock			Tilloch's Magazine, *loc. cit.*
—— —— 13.	Ditto	Ditto			Ditto.
—— —— 14.	Ditto	Ditto			Ditto.
—— Mar. 11.	Lyons				Ditto.
—— —— — 9h 10m P.M.	Ouches in the valley of Chamouni, and at St. Gervais.	Another violent shock, from S.W. to N.E., followed by eleven more shocks before dawn.		Accompanied by a loud detonation. Furniture was thrown down, and arches were broken. The glaciers cracked, and at the same instant lightning was observed over Mont Blanc, and a sort of light on the opposite side of the valley. The sky was serene.	Journ. des Débats, 22 et 27 Mars, 5 et 17 Avril; M. Studer's Catalogue.
—— —— — 9h 24m P.M.	Lausanne, throughout the canton, and at Berne, Neufchâtel and Geneva. Also felt at Yverdun, at Thun and other places in the Emmenthal as far as Wynigen.	Several shocks during the space of a min. At Berne the motion occurred (at 9 o'clock) and was but feeble.		In several places, especially at Geneva, articles of furniture were displaced, and doors opened. Almost everywhere, birds asleep in cages were thrown off their perches. At Yverdun a picture strongly hung was thrown on the floor. In another house a plaster ceiling, nearly new, was cracked in several places. Some hours later the western part of the château of Liebig near Arau fell, burying an old servant beneath the ruins. A sort of cracking noise was heard in many walls, which lasted after the shock had passed. Twenty-four hours before, a dull rumbling noise had been remarked, like a detonation at a great depth in the earth. From the 1st to the 8th of March the wind had been very violent in Switzerland, and on the 7th and 8th there were avalanches.	Ditto.

1.	2.	3.	4.	5.	6.
1817. Mar. 13. 7 A.M.	Ouches in the valley of Chamouni.	Another shock			Journ. des Débats, 22 et 27 Mars, 5 et 17 Avril; M. Studer's Catalogue.
—— —— —— $10^h 50^m$ A.M.	Ditto	Ditto			Ditto.
—— —— —— 11 A.M.	Ditto	Ditto			Ditto.
—— —— —— At noon.	Ditto	Ditto			Ditto.
—— —— —— $2^h 10^m$ P.M.	Ditto	Ditto			Ditto.
—— —— —— $11^h 20^m$ P.M.	Ditto	Ditto			Ditto.
—— —— 14. $5^h 50^m$ P.M.	Messina	A very violent shock		Accompanied by a tremendous noise	Moniteur, 11 Avril.
—— —— 15.	Ouches in the valley of Chamouni.	Another shock			Journ. des Débats, *loc. cit.*; Studer: Tilloch's Magazine, *loc. cit.*
—— —— 18. $10^h 45^m$ A.M.	In the part of Spain comprised between the two seas and the Pyrenees, from Santander to Tarragona; and in the region between Palencia, Toledo, and the mountains of Cuença. Most violent in the Rioxa, between Logrono, the right bank of the Ebro, and the frontier of Navarre. In other parts of the Rioxa, in Castille, Biscay, Arragon and Catalonia, the earthquake was but slight. Also felt at Lerida, Covella, Cientruenigo, &c.	A very severe shock. At Madrid, however, it was felt but slightly, as also at Santander, Palencia and Saragoza, and still less at Cuença and Barcelona (where some people said that it took place half an hour later than the time here given). In Navarre, at Pampeluna, and Albarracin it was rather severe. The shock seemed to come from the west. Throughout the Rioxa it recurred twice with an interval of a quarter		The sky had been clear and serene until $10^h 30^m$, but then became overcast; the sun disappeared, and a terrible obscurity began, with a cold and impetuous wind from the N.W., lasting until the shock took place. The latter was accompanied by rumbling subterranean noise. The buildings were much shaken, and chimnies, walls, and even some houses were thrown down. At Arnedo, Prejano, Arnedillo, Callahorra and Aurejo much damage was done. At Logrono everyone was thrown down. At Albarracin abundant hail followed the shock. The weather in Spain had been very variable for some months. A cold summer succeeded a winter so mild that the temperature was constantly 5 or 6 degrees above that of ordinary years, and in some places there had been a great drought for three months.	Moniteur, 14, 17 et 25 Avril; Journ. des Débats, 6, 7, 11 et 13 Avril; Ann. de Chim. et de Phys. t. lxv. p. 396; Tilloch's Magazine, *loc. cit.*

		of an hour, but not elsewhere.			
1817. Mar. 18. 11h 30m A.M.	Throughout the district of the Rioxa only.	Another shock			Ditto.
— — 3 P.M.	Ditto	Ditto			Ditto.
— — 11 P.M.	Ditto. On this same day oscillatory motion was observed at Pau, Ogenne, Dognen, Viellesegure, Oloron, and Bayonne, to the north of the Pyrenees.	Ditto. Followed by others, up to the 27th. M. Guttierrez says that there were 116 shocks in three months about this time.			Ditto.
— — 22. 11 or 11h 15m P.M.	At most of the places shaken on the 18th.	According to some this shock was more violent; according to others, less so than that of the 18th.			Ditto.
— — Night between 25 and 26.	Frascati, Genzano, and some other places in Italy.	Two shocks; the first of which was very slight, and the second very violent.			Journ. des Débats, 15 Avril; Tilloch's Magazine, *loc. cit.*
— — 26.	Ditto	Perhaps this account refers only to the second of the two shocks last mentioned.			Tilloch's Magazine, *loc. cit.*
— — 28.	Ouches in the valley of Chamouni.	Another shock		Accompanied by subterranean noise	Ditto; Journ. des Débats, 5 et 17 Avril.
— — 30.	Ditto	Ditto		Ditto	Ditto.
— — 31.	Ditto	Ditto, very violent			Ditto.
— April 1.	Ditto	Another			Ditto.
— — 2.	Ditto	Very violent; from N. to S. (or S. to N.?)			Ditto.
— — 15.	In Sicily	An earthquake		Some damage was done	Férussac, Bull. des Sci. Nat. t. iv. p. 9.
— — 16. 2h 30m A.M.	Appenzel in the canton of same name.	A severe shock		There had been a terrible storm the day before.	Journ. des Débats, 28 Avril; Studer.
— — ...	At Naples, and about the same period at Palermo.	Several shocks of considerable severity.		At Palermo strange howling noises were heard in the air, and large spots were observed on the sun. A very great eruption of Etna was the cause of the shocks at both places.	Moniteur, 17 Mai; Journ. des Débats, 16 et 21 Mai.

1.	2.	3.	4.	5.	6.
1817. April...	A place named Chang-Ruh, on the borders of the province of Sze-chuen, on the western frontier of China.	A violent earthquake.		Above 11,000 houses were thrown down, and more than 2800 persons killed.	Quart. Journ. of Roy. Inst. vol. vii. p. 191, quoting a Pekin Gazette of May 2.
—— May	Several places in Sicily.	Several shocks			Moniteur, 16 Juin.
—— June 10. $1^h 20^m$ P.M.	Urquhart, Dores, and near Inverness.	A smart shock			D. Milne on Earthquake Shocks felt in Great Britain; Edinburgh New Philosophical Journal, vol. xxxi. p. 118.
—— —— 16. 5 A.M.	Ditto	Two, similar to the last.			Ditto.
—— —— 30.	Inverness and neighbourhood.	Two very violent shocks.		Preceded by a storm and *hot* rain	Tilloch's Magazine, vol. li. p. 193.
—— July 7. 5 A.M.	Schaffhausen, and at same hour at Porrentruy in the canton of Berne.	At Schaffhausen a rather severe shock, which was more violent a league from the town. At Porrentruy also the motion was stronger in the environs.			Moniteur, 30 Juillet; Journ. des Débats, 28 Juillet; M. Studer's Catalogue.
—— —— 11.	Calcutta and the neighbourhood.	Shocks of trifling importance.			Garnier, *loc. cit.* p. 118.
—— Aug. 7. $8^h 20^m$ A.M.	Urquhart, Dores, and near Inverness.	A slight shock, more severe to the west of the town.		The French authorities quoted give the date Aug. 17.	D. Milne's Catalogue of British Earthquakes, *loc. cit.*; Moniteur, 5 Sept.; Journ. des Débats, 4 Sept.
—— —— 8.	At the hospice of the Grimsel.				M. Studer's Catalogue.
—— —— 11.	Saanen or Gessenay, canton of Berne.	Severe shocks			Ditto; Journ. des Débats, 29 Sept.
—— —— 13.	Ditto. Rougemont, to the west of Saanen, is mentioned.	Ditto. These shocks recurred almost every day, but with less violence, until the middle of September, when some of a great severity were felt (and espe-			Ditto.

		cially in the Canton du Vaud).			
1817. Aug. 19. About 5 P.M.	Innspruck	A very severe shock		A bell was caused to sound. The motion was stronger on the banks of the Inn than in the town.	Journ. des Débats, 3 Sept.; Moniteur, 4 Sept.
—— —— 23. About 8 A.M.	In the Morea, especially at Vostitza. But little perceptible at Corinth, but of remarkable intensity at Patras and in Elis.	Many and violent shocks, which did not cease for eight days.	The sea in the neighbourhood of Vostitza was heated to such an extent, that the fishermen scalded their hands by dipping them into it.	Preceded by subterranean noise and detonation. The town of Vostitza was destroyed in seventeen minutes, during a storm of opposite winds.	Journ. des Débats, 21 Nov. 1817 et 10 Janv. 1818; Mém. de Chronol. *loc. cit.*; Pouqueville, Voyage, t. iii. p. 559, t. iv. p. 413.
—— —— 31.	Urquhart, Dores, and near Inverness.	A smart shock			D. Milne's Catalogue, *loc. cit.*
—— Sept. 2. 3^h 30^m A.M.	Inverness	Another rather severe shock, the fifth since the beginning of August.			Journ. des Débats, 24 Sept.; Moniteur, 25 Sept.
—— —— 22. 2^h 30^m A.M.	Angoulême in the departm. Charente.	Rather violent shocks, from N. to S., lasting 2 or 3 seconds.		A loud detonation was heard at the termination of the shocks.	Journ. des Débats, 7 et 22 Oct.; Moniteur, 10 Oct.
—— —— ...	Madras			Earthquakes are said to be of extreme rarity at this place.	Garnier, *loc. cit.*
—— Oct. 17. 3 P.M.	Yvonand in the Canton du Vaud.	A rather violent shock.			Journ. des Débats, 27 Oct.; Studer.
—— —— 18.	In Sicily, at Catania and Cattaro.	A slight trembling			Ann. de Chim. et de Phys. *loc. cit.*; Bull. Univ. t. ix. p. 229.
—— —— 21. 10^h 30^m P.M.	St. Helena	Several successive shocks, lasting altogether 2 minutes.	Ships in the bay were agitated.	Articles were thrown from shelves, and the bells rang. Beasts and birds showed signs of terror.	Gentleman's Magazine, vol. lxxxvii. pt. 2. p. 622.
—— —— 31.	Smyrna	A rather severe shock, which lasted several seconds, and was followed by others a little later.			Journ. des Débats et Moniteur, 28 Déc.
—— —— ——	Macquarie Island in the S. Pacific.	Violent shocks, recurring frequently during the remainder of 1817, and up to April 1818.		Accompanied by subterranean noise	Garnier, *loc. cit.*

1.	2.	3.	4.	5.	6.
1817. Nov. 9.	Parts of Yorkshire, Westmoreland, and Lancashire.	....	....	....	Gentleman's Magazine, vol. lxxxviii. pt. 2.
—— —— 12. About 3 A.M.	Geneva and the neighbourhood.	A severe shock. The direction was *from above downwards* (!)?	The waters of the lake of Geneva were momentarily raised.	Accompanied by a loud detonation and noise like the fall of a very heavy body.	Journ. des Débats, 21 et 24 Nov.; Moniteur, 1 et 8 Déc.; Studer.
—— —— 19. 2 A.M.	Longué near Saumur, in the departm. Maine-et-Loire.	A rather severe shock.	....	....	Journ. des Débats, 10 Déc.
—— —— 20.	Gadmen in the Bernese Oberland.	A trembling. About this time several shocks were felt in the same district.	....	....	Journ. des Débats, 21 et 24 Nov.; Moniteur, 1 et 8 Déc.; Studer.
—— —— 22. At night.	In Greenland	A severe shock	....	Hecla was perfectly quiet at the time	Quart. Journ. Roy. Inst. vol. v. p. 135.
—— Dec. 2?.	St. John in the island of Antigua.	Shocks of the most alarming character, lasting several secs.	....	....	Moniteur, 23 Fév. 1818; Journ. des Débats, 24 Fév. 1818.
1818. Jan. 9. 8h 9m A.M.	Hayfield in Sweden ...	One shock	....	....	Ann. de Chim. et de Phys. t. xxxiii. p. 402; Garnier.
—— —— ...	Athens	....	Accompanied by an inundation of the sea.	....	Gentleman's Magazine, vol. lxxxviii. pt. 1. p. 71.
—— Feb. 6.	Coningsby in Lincolnshire.	Slight. Lasted some seconds.	....	A subterranean noise like the firing of cannon was heard at this time. At the east of Holderness, and in the neighbourhood of Trentfall, 50 miles from Coningsby, the noise was also heard. At the first place the sound was like that of horses running away with a waggon; at the latter it resembled distinct gun-shots, and then died away to a sort of grumbling. It lasted about two minutes, and seemed to shift from E. to S.	Ditto, vol. lxxxviii. p. 1. p. 171; Quart. Journ. Roy. Inst. vol. v. p. 135; Ann. de Chim. et de Phys. t. ix. p. 433.
—— —— 19. 10h 30m P.M.	Rouffach, Soultz, and Belfort in the departm. Haut-Rhin. Not felt at Colmar.	A severe shock	....	....	Ann. de Chim. et de Phys. t. ix. p. 433; Journ. des Débats, 6 Mars; Journ. de Phys. t. lxxxviii. p. 35; Garnier.
—— ——	In Aberdeenshire	....	....	....	D. Milne's Catalogue, *loc. cit.*
—— —— 20. 1h 20m P.M.	Inverness	....	....	....	Ditto.

1818. Feb. 20. 3 P.M.	Coningsby in Lincolnshire and the country round. Felt also at Kirton in Lindsey.	………………	………………	Accompanied, as the former shock, by noises like the firing of cannon. At Kirton in Lindsey a meteor was seen about the size of a cannon-ball, with a luminous streamer behind it, and moving with great velocity.	Gentleman's Magazine, vol. lxxxviii. pt. 1. p. 364.
— —— — 7^h 10^m P.M.	At Catania, and in Calabria and Malta.	A severe shock, followed by another of less intensity, during the night. The motion was from S.E. to N.W., according to some oscillatory, and lasted, by varying accounts, from 10 to 40 seconds.	The sea was calm during the morning, but rose in froth upon the shore, owing to an unperceived (distant?) storm. At a place on the coast where the sea was tranquil, a vessel at anchor touched (or seemed to touch?) the bottom thrice with her keel.	The sky was clear, the air calm and mild. The moon was beautifully bright. Animals showed signs of alarm before the earthquake. Etna had been quiet since 1811, but at dawn this day flames were observed issuing from small cracks in the old beds of lava, accompanied by slight explosions. The water in wells was troubled some days before the shocks; and at a place named Paraspolo, fourteen considerable jets of salt water rose suddenly with a loud noise from the earth to the height of 6 palms. This phænomenon occurred five or six minutes before the shock, and lasted about twenty minutes. The apertures from which the water had issued were so hot two days afterwards that it was impossible to plunge the hand into them. Near the same place a subterranean noise like thunder was heard. The water in the basins of public fountains was in part thrown out at each shock. Some statues were remarked as having been moved a little in azimuth; and a considerable mass of stone at Syracuse was turned 25° from the east towards the south. The walls in some houses were seen to open *horizontally* (?), so that the light of the moon penetrated for an instant, and then closed again, without leaving very perceptible traces of fracture. In Catania great masses of stone were thrown from the tops of buildings, and a colossal statue of an angel lost both its arms, as if they had been cut sharply off. At many other places public and private buildings were thrown down, and 69 persons were killed or wounded. The atmosphere soon after became cloudy.	Ann. de Chim. et de Phys. t. ix. p. 433, t. xix. p. 435 et suiv., t. xxi. p. 402; Journ. des Débats, 26 et 31 Mars; Bibl. Univ. t. ix. Nov. 1818, p. 228.

1.	2.	3.	4.	5.	6.
1818. Feb. 22. 7h 13m (A.M. or P.M.?).	Turin	A shock from N. to S.			Mém. de l'Acad. de Turin, t. xxiii. p. 397.
—— ——	Genoa and Milan	Two shocks			Ditto.
—— —— 23.	Turin, Genoa, Savena, Alanco, and San Remo.	At Turin there were two shocks; at the other places they continued at intervals for two days.		During a storm which raged this day over Provence and the north of Italy. At some towns several houses were injured.	Quart. Journ. Roy. Inst. vol. v. p. 134.
—— —— —— 7 P.M.	Marseilles, Draguignan, Oreille in Savoy, Antibes and Vence in the departm. Var.	At the first three places the shocks were very severe, and from N.W. to S.E. At Antibes there were three oscillatious from S.E. to N.W. in 3 seconds.	At Antibes the sea dashed violently against the rocks just before the shock.	Accompanied by a dull subterranean noise. At Antibes the weather had been very rough; at a few minutes past 7 P.M. a tremendous rush of wind took place, and then sank into a calm; the subterranean noise was then heard, and the shock took place. The wind then rose, and the storm raged as before. At Vence several houses fell. This shock and the following ones were felt throughout Provence, where no earthquake had been experienced for eleven years before.	Ditto; Ann. de Chim. et de Phys. t. ix. p. 433, t. xxxiii. p. 402; Journ. des Débats, 6 et 12 Mars; Moniteur, 12 Mars; Journ. de Phys. t. lxxxviii. p. 35.
—— —— —— Midnight.	Antibes	Another shock			Ditto.
—— —— 24. 11 A.M.	Marseilles, St. Remi (Bouches-du-Rhône), and in part of the departm. Var.	Ditto. On this day and the following several shocks were felt in the Var.			Ditto.
—— —— —— Near mid-day.	Antibes	Another shock		Preceded by the same smothered rumbling noise as before.	Ditto.
—— —— Night between 24 and 25.	In the Madoines (Sicily). Felt over a very limited district. The centre of disturbance seemed to be in the neighbourhood of Petroli and Polizzi.	Shocks began on this night which continued from time to time until April 1819. The most considerable were these first shocks and those of the 8th Sept.		Cracks opened in buildings at Geraci and some other places, and here and there considerable damage was done.	Férussac, Bull. des Sc. Nat. t. v. Juil. 1825, p. 317.
—— —— 25. 10 A.M.	Vence, Marseilles, and Aix.	A slight shock			Ann. de Chim. et de Phys. &c. just quoted.

1818. Feb. 25. $11^h\ 15^m$ P.M.	Ditto	Ditto			Ditto.
—— —— 27.	Catania				Ditto, t. xxxiii. p. 402.
—— —— 28.	Ditto	Two more shocks		Did great damage	Ditto, and other authorities quoted above.
—— Night between 28th Feb. and 1st March.	The Mauritius	Shocks were *supposed* to have been felt.		During a tempest comparable to that of 1786	Journ. des Débats, 21 Juin.
—— March 1.	St. Remy in the Puy-de-Dôme.	A slight shock			Ann. de Chim. et de Phys. t. xxxiii. p. 402; Garnier.
—— —— 2. 4 A.M.	In the departm. Var, and at Nice.	Ditto. Lasted 4 secs. Followed by three oscillations after an interval of 8 secs.			Ditto.
—— —— ——	In the Val-di-Noto, Sicily.	Rather severe shocks.		A column of smoke rose at the same time from Mount Etna.	Ditto.
—— —— 9.	St. Remy. (In the Puy-de-Dôme, in the Bouches-du-Rhône, or S.W. of Savona?)	Another slight shock.			Ditto, p. 403.
—— —— 15.	Ditto	Ditto			Ditto.
—— —— 18.	Bencoolen in Sumatra		The effects of this earthquake were experienced at a considerable distance out to sea.	Very little damage done.	Quart. Journ. Roy. Inst. vol. vi. p. 168.
—— —— ?	Philippoli in Romania	An earthquake		This city of 70,000 inhabitants is said to have been entirely swallowed up in subterranean chasms, so that no traces of it remained. The account is manifestly exaggerated; but what foundation, if any, had it? The event is said to be announced in letters from Bucharest of the 17th March, but the date of the earthquake is not given.	Journ. des Débats, 11 Juin.
—— April 8. $0^h\ 18^m$ A.M.	Commune of Latour in Piedmont.	A violent shock at the time mentioned, followed by four more; and, two hours after, by other slighter ones.		The inhabitants left their houses	Ann. de Chim. et de Phys. *loc. cit.*; Quart. Journ. Roy. Inst. vol. v. p. 372.

1.	2.	3.	4.	5.	6.
1818. April 9.	Commune of Latour in Piedmont.	Several slighter shocks			Ann. de Chim. et de Phys.
—— —— 30.	Ancona	A single shock of trifling importance.			Ann. de Chim. et de Phys. t. ix. p. 433.
—— —— ...	Extending from one side of Lincolnshire to the other, and across Holderness in Yorkshire.	A smart shock			D. Milne's Catalogue of British Earthquakes, *loc. cit.*
—— May 3.	Ancona	A strong shock			Ann. de Chim. et de Phys. t. xxxiii. p. 403.
—— —— 16. Between 2 and 3 A.M.	Island of St. Thomas in the West Indies. The Moniteur says Ile de la Trinité, perhaps Trinidad.	A severe shock, followed by another at $9^h 30^m$ A.M. (9^h according to the Moniteur.)			Quart. Journ. Roy. Inst. vol. vi. p. 168; Moniteur, 8 Sept.
—— —— 17.	Motz in Savoy	From S.E. to N.W.		Preceded by loud detonations. The sky was serene.	Ann. de Chim. et de Phys. t. xxx. p. 403; Garnier.
—— —— 21. 9 P.M.	Island of Martinique	A slight shock			Ann. de Chim. et de Phys. t. xxxiii. p. 403; Garnier.
—— —— 28. A little before midnight.	Brudeis (Budweis ?), Kranau, Rosenberg, and in the mountains between Bohemia and Austria.	Very violent shocks; most severe in the highest parts of the mountains.			Ditto; Gentleman's Magazine, vol. lxxxviii. pt. 1. p. 554.
—— —— 31. Early in the morning.	At Mexico	A severe earthquake		Many of the public and other buildings of the city and neighbourhood suffered materially. Amongst others, a number of the arches of the aqueduct of Santa Fé were rent, and discharged quantities of water.	Ann. de Chim. et de Phys. t. xii. p. 425; Moniteur, 16 Nov.; Quart. Journ. Roy. Inst. vol. vi. p. 370.
—— June 1.	Jamaica	A violent shock, felt throughout the whole island.			Ann. de Chim. et de Phys. t. xxxiii. p. 403, t. viii. p. 415; Garnier.
—— —— 9. $2^h 20^m$ P.M.	Loch Awe, Scotland			Preceded by a loud rumbling noise	Tilloch's Magazine, vol. li. p. 467.
—— —— 19.	Comrie in Perthshire	Two shocks, with an interval of a minute.			D. Milne's Catalogue of British Earthquakes, *loc. cit.*
—— July 19. 7 A.M.	Perpignan, Pau, and throughout the valley of Orthez.	Some shocks in the direction of the chain of the Pyrenees.		Said to be accompanied by heavy rain, and followed by great electrical explosions. Stormy weather was frequent after the shocks.	Journ. des Débats, 1 et 8 Août; Moniteur, 2 Août; Ann. de Chim. et de Phys. t. ix. p. 433; Quart. Journ. Roy. Inst. vol. vi. p. 168.

1818. July 22. 10 P.M.	Innspruck in the Tyrol.	A severe shock, from W. to E.; the oscillation lasting some seconds.		Accompanied by a rolling noise like thunder	Ann. de Chim. et de Phys. t. ix. p. 433; Quart. Journ. Roy. Inst. vol. vi. p. 168.
—— —— 27. 1 P.M.	Albano in Italy	A slight shock		The Quarterly Journal of the Roy. Inst. gives the date *August* 27.	Journ. des Débats, 15 Août; Ann. de Chim. et de Phys. t. xxxiii. p. 403.
—— —— 30. 4h 44m P.M.	Jassy in Moldavia	A violent shock, lasting some seconds. A second, of less violence, was supposed to have been felt about midnight.			Journ. des Débats, 10 Sept.; Moniteur, 12 Sept.; Quart. Journ. Roy. Inst. vol. vi. p. 169.
—— —— End of the month.	At Mexico	Severe shocks			Ann. de Chim. et de Phys. t. xxxiii. p. 403.
—— —— …	Jamaica				Gentleman's Magazine, vol. lxxxviii. pt. 2. p. 173.
—— Aug. 3. 8 A.M.	Castiglione in Italy	A rather severe shock.			Ann. de Chim. et de Phys. *loc. cit.*
—— —— 5. At night.	Rome, Albano, and Frascati.	Ditto			Ditto.
—— —— 8.	In the island of Candia.	A severe shock			Ditto; Moniteur, 27 Oct.
—— Sept. 1.	Inverness in Scotland				D. Milne's Catalogue, *loc. cit.*
—— —— 8. 5h 30m (A.M. or P.M.?).	Cuneo in Piedmont	A shock of rather long duration.			Ann. de Chim. et de Phys. *loc. cit.*
—— —— —. 11h 30m P.M.	Palermo. The shock seemed to be confined in extent to the city.	A severe shock			Ditto; Journ. des Débats, 6 et 8 Oct.; Moniteur, 9 Oct.
—— —— 21.	A league and a half to the west of Lisbon, but not in the city itself (!).	A very violent shock.			Moniteur, 13 Oct.; Ann. de Chim. et de Phys. t. ix. p. 433.
—— Oct. 2. 1h 30m P.M.	Brutensorg. Batavia. Felt in the mountains as well as in Batavia.	A very smart shock, lasting but a few seconds.		The houses were violently shaken, windows rattled, mortar fell from the walls, and bells rung. Some houses had the walls rent open. People who were standing up became giddy by the motion of the ground.	Quart. Journ. Roy. Inst. vol. vii. p. 396; Garnier.
—— —— 11.	Along the base of the mountain to the north of Quebec.			The windows and furniture of the houses were shaken.	Quart. Journ. Roy. Inst. vol. vi. p. 370; Ann. de Chim. et de Phys. t. xii. p. 425.

1.	2.	3.	4.	5.	6.
1818. Oct. 31.	Dalton in Low Furness, Lancashire.	....	....	It is said that a shock was felt at the same place about a year before, and that such convulsions are not rare in the line of country which extends along the western coast from Lancashire to Ayrshire.	Quart. Journ. Roy. Inst. vol. vi. p. 370; Ann. de Chim. et de Phys. t. xii. p. 425.
—— —— ...	In Iceland	A dreadful shock......	....	Accompanied by subterranean noises and horrid crashes, at the close of which an eruption from Mt. Hecla commenced.	Ditto.
—— Nov. Night between 4 & 5.	Aquisgrana (Aix-la-Chapelle). The same shocks were felt in the whole of the town of Witchbach.	A shock of but little violence, followed, after sunrise, by a second, which was again succeeded in a few minutes by renewed motion.	....	The last felt motion was accompanied by a noise like that of a distant cannonade.	Ann. de Chim. et de Phys. t. xxxiii. p. 403; Moniteur, 14 Nov.
—— —— 11. 0h 20m A.M.	Inverness, and to some distance round the town. Felt with great violence along the banks of Loch Ness.	Two shocks, in three seconds. Preceded on the evening of the 10th and succeeded the next morning by slighter shocks.	....	Accompanied by a noise like thunder. Bells rang of themselves.	Gentleman's Magazine, vol. lxxxviii. pt. 2. p. 557; Ann. de Chim. et de Phys. t. xii. p. 425; Moniteur, 27 Nov.; Quart. Journ. Roy. Inst. vol. vi. p. 370.
—— —— *Before* the 14th.	In the neighbourhood of Lisbon.	Several slight shocks had been felt for some time before the 14th.	....	Occasioned much alarm	Moniteur, 12 Déc.
—— —— 20.	Cap Henri in St. Domingo.	Two severe shocks ...	....	Five persons were killed and some houses were destroyed.	Ann. de Chim. et de Phys. t. xxxiii. p. 403 et t. viii. p. 415; Moniteur, 18 Janv. 1819; Quart. Journ. Roy. Inst. vol. vii. p. 191.
—— Dec. 7. 9 A.M.	Bangor in N. Wales, and, much more sensibly, in the neighbourhood of Penter.	Very slight at Bangor.	....	At Penter the motion was described as being as if the earth had sunk nearly a yard under the feet. The Ann. de Chim. et de Phys. mentions another slight shock as felt at this place on the 14th at 9 A.M., but it is probably confounded with the event here recorded.	Quart. Journ. Roy. Inst. vol. vi. p. 371; Ann. de Chim. et de Phys. t. ix. p. 433 et t. xxxiii. p. 403.
—— —— 8. 7 P.M.	Parma, Genoa, Modena, Reggio, and Leghorn.	At Parma the shock was rather feeble; at the other places it was more intense.	....	....	Ann. de Chim. et de Phys. *loc. cit.*; Journ. des Débats, 31 Déc.

1818. Dec. 9.	Parma	The oscillations, from S. to N., lasted fourteen seconds.		A church fell	Ditto.
—— —— 10. 10 P.M.	Reggio	Another slight shock.			Ditto.
—— —— 20.	Island of St. Domingo	A violent shock		From this month up to the 21st May 1819, eight earthquakes were felt in the Antilles, of which seven occurred between 9 and 11 P.M. The motion consisted *as usual* of gentle oscillations without actual shocks.	Ann. de Chim. et de Phys. t. xxxiii. p. 403, t. viii. p. 415; Cuvier, Hist. des Sc. Nat. t. ii. p. 169.
—— ...	Copiapo				Phil. Trans. for 1836, p. 21.
1819. Jan. 8.	Genoa. Not felt at Nice or Alassio.		Vessels at sea were very much agitated, so that the shock was supposed greater there than on land.	Several of the inhabitants fled into the country.	Ann. de Chim. et de Phys. t. xii. p. 426.
—— —— 17. Between 1 and 2 P.M.	Aamodt in the Osterdal, Sweden.	Began by a rolling motion from W. to E., which was followed by a shock of short duration.		In some places furniture was moved about and the glasses were caused to ring.	Registidenden for 1819, Nr. 10.
—— —— 24 and 25.	St. Ubes in Portugal	Several slight shocks.			Ann. de Chim. et de Phys. t. xxxiii. p. 404; Quart. Journ. Roy. Inst. vol. vii. p. 191.
—— —— 29. At night, particularly about 10 o'clock.	Tiflis in Georgia	Several shocks, which became very violent at 10 o'clock.		Preceded by tempestuous weather and subterranean noises. The earth was rent in many places, and many old buildings were destroyed. Perhaps the event of the 28th February is only the same with this.	Quart. Journ. Roy. Inst. vol. vii. p. 397.
—— —— ...	Tabriz in Persia	Very numerous shocks, extending over several weeks, about this time; the exact days not mentioned.			Silliman's Journal, vol. xxxvii. p. 351.
—— Feb. 1. 8 A.M.	Parma	A slight shock			Ann. de Chim. et de Phys. t. xxxiii. p. 404.
—— —— 8.	Genoa	Violent shocks		The towns of Port-Maurice and San-Remo were injured. The date should probably be January 8.	Huot, Géol. t. i. p. 114.

1.	2.	3.	4.	5.	6.
1819. Feb. 11. 5 P.M.	Ballenloan in Glenlyon, Scotland.	A smart shock	....	Immediately followed by a tremendous gale and much snow.	Quart. Journ. Roy. Inst. vol. vii. p. 191.
——— 24. At night.	Palermo	Several shocks........	....	Some houses were shaken down. During the fourteen days preceding the 4th of March the weather was dreadful, and three shocks of earthquake occurred.	Ann. de Chim. et de Phys. t. xii. p. 426.
——— Same night.	Near Morbio in the Canton of Ticino.	A trembling...........	....	....	Ditto.
——— 26.	Rome, Frascati, and Albano.	Shocks from S.E. to N.W.	....	....	Ditto.
——— 28. At night.	Tiflis in Georgia	Several shocks........	....	Preceded by subterranean noise. Old houses were thrown down.	Ditto.
——— End of the month.	In Syria	Severe shocks	....	....	Ditto.
— March 7.	Kiachta on the frontiers of China.	A prolonged shock ...	....	....	Ditto, t. xxxiii. p. 404.
——— 18.	Fort Marlborough on the western coast of Sumatra.	A very violent shock .	....	....	Garnier, Météor. p. 123.
———	Oran and Mascara, in Morocco.	Shocks lasting an hour.	....	A great number of the inhabitants disappeared beneath the ruins.	Ann. de Chim. et de Phys. t. xii. p. 426.
— April 3.	Copiapo in Chili	Very violent	....	The whole city was destroyed by the shocks of this day and of the 4th and 11th. The inhabitants had barely time to save their lives.	Quart. Journ. Roy. Inst. vol. viii. p. 355; Garnier, Météor. p. 123.
——— 4.	Ditto	Ditto	....	....	Ditto.
——— 8.	Temeswar in Hungary ..	Three shocks	....	....	Ann. de Chim. et de Phys. t. xii. p. 426.
——— 10.	Landshut and Augsburg.	A slight shock........	....	....	Ditto; Quart. Journ. Roy. Inst. vol. vii. p. 397.
——— 11.	Copiapo	The last of the three dreadful shocks of this month.	....	....	Quart. Journ. Roy. Inst. vol. viii. p. 355; Garnier, *loc. cit.*
— May 26. 6 P.M.	Corneto in the States of the Church. The shocks were felt along the Mediterranean.	....	....	Several houses fell, and a great number of people perished.	Ann. de Chim. et de Phys. *loc. cit.*; Journ. des Débats, 17 Juin; Annual Register, 1819, p. 39.
——— 27. 1 A.M.	In Sicily	A violent shock	....	An eruption of Etna began, the mountain having been perfectly at rest for the preceding three years.	Ann. de Chim. et de Phys. *loc. cit.*; Journ. des Débats, 26 Juin.

1819. May. End of the month.	In the neighbourhood of Viterbo.	Violent shocks	....	Doubtless the same with those at Corneto on the 26th.	Journ. des Débats, 26 Juin.
—— June 16. Between 6^{h} 45^{m} and 50^{m} P.M.	Cutch, and other parts of the north of India, including a space of about 18° lat. by 20° long. Extended north as far as Ahmedabad, where much damage was done. Also slightly felt at Poonah.	The severe shocks lasted about two minutes and a half, and their general direction was probably from S.W. to N.E.	....	The violence of this remarkable earthquake was so great that people could scarcely keep their feet, and the waving motion of the ground was quite visible. The earthquake was accompanied by a violent gust of wind and a noise like that of a large flight of birds. Many meteors or falling stars were observed on the night after. Many other shocks occurred during the night, and at intervals until the 23rd of November. The whole district of Cutch was ravaged, and Bhooj, the capital, was changed to a heap of ruins, 2000 of the inhabitants perishing. Many other towns and villages suffered much. The most remarkable effects of this earthquake were the subsidence of "Sindree" and elevation of the "Ullah Bund," for details of which see Lyell's 'Principles of Geology.'	Transactions of the Literary Society of Bombay, vol. iii. p. 90.
—— —— 8^{h} 20^{m} P.M.	Calcutta, Muttra, Chunar, Mirzapora, Mynpooree, Jionpoor, Sultanpoor, Surat, Broach, Kaira, &c.	Two shocks with an interval of about two minutes. The first lasted thirty or forty seconds. At Jionpoor there were three distinct oscillations from W. to E., lasting twenty-five secs. At Sultanpoor the shock was very awful.	....	....	Asiatic Journal, vol. ix. pp. 70, 79, 184, 307, 310, 384; Quart. Journ. Roy. Inst. vol. viii. p. 356, vol. ix. p. 206; Lyell, Geol. p. 437.
—— —— 17.	Ditto	Another shock	....	....	Ditto.
—— —— 18.	Ditto	Two ditto	....	....	Ditto.
—— —— 20.	Ditto	Two more shocks ...	....	On this day the volcano called Denodur, thirty miles N.W. from Bhooj, is said to have burst into eruption, and the convulsions ceased.	Ditto.
—— July. Night between 1 and 2.	Catania; felt still more strongly at Chiaramonte.	A very severe shock .	....	The eruption of Etna continued, but with so much smoke that no flame was visible.	Journ. des Débats, 11 Août.

1.	2.	3.	4.	5.	6.
1819. July 10. 6h 45m P.M.	Guérande in the departm. Loire-Inférieur.	A slight shock from N. to S.		Accompanied by noise like prolonged thunder	Journ. des Débats, 24 Juillet; Ann. de Chim. et de Phys. t. xii. p. 426.
—— —— 28.	Munich	A severe shock			Ann. de Chim. et de Phys. t. xxxiii. p. 404.
—— —— End of the month.	Olette in the eastern Pyrenees.	A slight shock			Ditto, t. xii. p. 426.
—— Aug. 5.	Constantinople	A severe shock			Ditto, t. xxxiii. p. 404.
—— —— 12. 2h 30m A.M.	Island of Trinidad	Undulatory motion from E. to W., very severe, and lasting four or five seconds.		Preceded by a rushing noise, as of wind. It was a clear moonlight night, and nothing particular was remarked in the state of the atmosphere. Two shocks were also felt at the same time in Grenada and St. Vincent.	Quart. Journ. Roy. Inst. vol. viii. p. 356; Ann. de Chim. et de Phys. t. xii. p. 426; Moniteur, 24 Nov.
—— —— 15.	St. Andrews in Lower Canada.			Attended by noise like the firing of cannon	Tilloch's Magazine, vol. liv. p. 316; Ann. de Chim. et de Phys. t. xii. p. 426.
—— —— 18. Between 9h 15m and 11h 45m A.M.	Voss in Sweden	Five shocks, of which the first was the most severe.		The noise was like that of a carriage passing rapidly over a stone bridge.	Rigstidenden for 1819. Nr. 20.
—— —— 29.	Staltdalen (Saltdalen?) in Norway.	A shock			Ann. de Chim. et de Phys. t. xii. p. 426; Bull. de la Soc. Géol. t. vii. p. 29.
—— —— 30.	Ditto	Ditto			Ditto.
—— —— 31. At Saltdalen at 2h 30m P.M. At Hemnoes at 2h 30m. At Statsbygden, 2 miles from Drontheim, at 3h 15m (?).	Throughout a large district in Norway. Especially at Salten and Helgeland in the province of Nordland. At Frosten and at Drontheim shocks were also felt, but more feebly.	At Saltdalen the shock seemed to come from the S.W., and to extend across the Fiord. The shocks lasted six minutes, and were followed by other slight ones at 5h and 7h 5m P.M. At Lunröe the direction seemed to be S. to N., and the shocks lasted ten minutes, followed by others hourly	At Hemnoes the sea was as much agitated as in the most violent tempests, although the air was calm.	At Saltdalen there was a loud noise; the houses shook, and the windows rattled. The water of a little stream was rendered turbid. At Lunröe also streams were disturbed, and stones of considerable size were rolled down from the hills. At Hemnoes chimnies were thrown down and water thrown up into the air. Noises accompanied by slight shocks were heard almost every day up to the 20th of October.	Ditto; Rigstidenden for 1819, Nrs. 83, 85, and 99.

		morning. At Hemnoes the direction seemed to be E. to W., and at Statsbygden it was S. to N.			
1819. Aug. 31.	Vrola in Russian Lapland.	A vibration sufficiently strong to throw down chairs and other furniture.	....	....	Moniteur, 20 Nov.
—— —— ...	Venice	A trembling...........	....	....	Ann. de Chim. et de Phys. t. xii. p. 426.
—— Sept. 4. 9 P.M.	Corfu	Two violent shocks, directed towards the north (S. to N.?).	....	All the bells of the town rang from the effect of the shock. The moon shone very brightly, and the air was quite serene. The Quart. Journ. Roy. Inst. gives the date Sept. 11.	Ditto; Quart. Journ. Roy. Inst. vol. ix. p. 205.
—— —— 28 and 29.	Lunröe in Norway	Slight shocks	....	....	Keilhau.
—— —— ...	Irkutsk	A violent shock	....	....	Ann. de Chim. et de Phys. t. xxxiii. p. 404.
—— Oct. Night between 2 and 3.	Saltdalen, Drontheim, &c. in Norway.	An earthquake	....	Preceded by a very loud noise, which appeared to pass from W. to E.	Ditto.
—— —— 16. One hour after midnight (of the 15th?).	Island of Martinique. Also felt at St. Lucia.	The duration of the shocks was more remarkable than their intensity.	....	Occurred during a violent gale of wind	Ditto, t. xii. p. 426; Moniteur, 24 Nov.
—— —— ——	Lunröe in Norway	More shocks	....	....	Memoir of M. Keilhau on Norwegian earthquakes.
—— —— 19 and 20.	Island of St. Thomas's in the West Indies.	Three shocks	....	During the hurricane which blew on these days.	Quart. Journ. Roy. Inst. vol. viii. p. 356.
—— —— 20.	Hemnoes in Norway ...	A slight shock	....	....	Keilhau.
—— —— 31.	Plauen in Saxony	A very severe shock...	....	....	Ann. de Chim. et de Phys. t. xxxiii. p. 404.
—— Nov. 10.	Lunröe in Norway	A severe shock	....	....	Keilhau.
—— —— About the middle of the month.	Montreal in Canada ...	A slight shock.........	....	Followed by an awful storm, during which rain fell of an inky colour, apparently impregnated with a matter like soot.	Quart. Journ. Roy. Inst. vol. ix. p. 205; Ann. de Chim. et de Phys. t. xv. p. 421.
—— —— 21.	Lunröe in Norway	Another slight vibration.	....	....	Keilhau.

1.	2.	3.	4.	5.	6.
1819. Nov. 28. 1h 30m A.M.	Comrie in Perthshire, extending several miles round the village.	A severe shock from the N.W.; lasted 10 secs. More alarming than any felt here for ten years before.		Accompanied by the usual hollow grumbling sound. Furniture, plates, &c. were moved about and jingled.	D. Milne's Catalogue, *loc. cit.*; Quart. Journ. Roy. Inst. vol. ix. p. 205; Ann. de Chim. et de Phys. t. xii. p. 426.
—— Dec. 3.	Lunröe in Norway	Another slight shock			Keilhau.
—— —— 4. 7h 30m P.M.	Amalree in Scotland	A smart shock, lasting two or three seconds. Direction, —by the Grampian Hills eastward.		Houses and furniture shook, and the whole went away with a noise like the slow passing of carts.	Quart. Journ. Roy. Inst. vol. ix. p. 205; Ann. de Chim. et de Phys. t. xv. p. 421.
—— —— 17.	Lunröe in Norway	Another slight shock			Keilhau.
—— —— 20. 7h 55m A.M.	Mittenwald in Bavaria	Shocks from S. to N., lasting seven or eight seconds.			Ann. de Chim. et de Phys. t. xv. p. 421; Quart. Journ. Roy. Inst. vol. ix. p. 206.
—— —— Night between 24 and 25.	Foligno in Italy	Several shocks			Ann. de Chim. et de Phys. t. xxxiii. p. 404.
1820. Jan. 3.	Lunröe in Norway	A feeble shock			Keilhau.
—— —— 10.	Ditto	Ditto			Ditto.
—— —— 12.	Ditto	A severe shock			Ditto.
—— —— 17. 4 A.M.	Pistoia in Tuscany	Undulatory, from W. to E., lasting four or five seconds.		Accompanied by very loud noise. An eruption of Vesuvius began on the 16th.	Ann. de Chim. et de Phys. t. xxxiii. p. 404.
—— —— 19. 6 A.M.	Voss in Norway	A rather severe shock			Keilhau.
—— —— 20.	Lunröe in Norway	A severe shock			Ditto.
—— —— 22. 8h 30m A.M.	Port Glasgow; also felt at Condrie (Comrie?), Perthshire, Kippin, Dumbarton, &c., at the same time.	A strong earthquake, consisting of three distinct shocks, coming apparently from the N.	The waters of Loch Lomond were agitated and rose somewhat, so that some persons who were crossing it were alarmed by the sudden rippling of the water.	The rumbling noise as well as the motion seemed to come from the north. A rapid thaw had commenced that morning, succeeding a long and sharp frost.	Quart. Journ. Roy. Inst. vol. ix. p. 206; Ann. de Chim. et de Phys. *loc. cit.*
—— —— 27. Noon.	Bhooj in Cutch, Hindostan.			Attended by a loud noise like distant thunder	Trans. Lit. Soc. of Bombay, vol. iii. p. 90.

1820. Jan. 29. 3 P.M.	Island of Martinique	Two shocks of but short duration.			Ann. de Chim. et de Phys. t. xv. p. 422.
—— ——	Lurröe in Norway	A strong shock			Keilhau.
—— —— 31 to March 28.	Island of S^ta^ Maura in the Archipelago.	Altogether 424 shocks, apparently from various directions. Six of the shocks were much more violent than the rest, the worst of all occurring on the 17th of March.		Accompanied by subterranean noises. Vesuvius exhibited more than usual agitation during the whole of this period.	Brugnatelli, Giornale di Fisica, 1820, p. 144.
—— —— and February.	Moor in Hungary	Numerous shocks		Great damage done.	Langlois, Dict. de Géogr. art. Moor.
—— Feb. 8.	Lurröe in Norway	A slight shock			Keilhau.
—— —— 21.	S^ta^ Maura	A shock, said in the Ann. de Chim. et de Phys. to be the most violent of those felt about this time in S^ta^ Maura.		A dull noise was heard from the morning, followed by a violent storm, and afterwards the shock. Numbers of the buildings fell, and the square in the centre of the town sank. A new island was said to have appeared in the neighbourhood.	Ann. de Chim. et de Phys. t. xv. p. 422.
—— —— 23. 11^h^ 30^m^ P.M.	Chiatimone	A shock		During a violent eruption of Vesuvius	Ditto, t. xxxviii. p. 142.
—— Mar. 3. At night.	Unalaska, one of the Aleutian Isles.	A great shock		Accompanied by a very intense subterranean noise. A new volcano appeared in the island of Turinak, 100 wersts from Unalaska.	Garnier, Météor. p. 127.
—— —— 17. 9 A.M.	S^ta^ Maura	According to the Giornale di Fisica, the worst of the shocks of this period.			Brugnatelli, Giornale di Fisica, 1820, p. 144.
—— —— ...	Island of Chios	One shock		In the midst of a great tempest. Much damage done.	Ann. de Chim. et de Phys. t. xv. p. 422.
—— April 2.	Lurröe in Norway	A strong shock			Keilhau.
—— —— 6. Between 2 and 3 A.M.	Cork, Ireland, and the neighbouring towns.	Shocks		Accompanied by a noise like the rolling of a heavy carriage over pavement.	Ann. de Chim. et de Phys. t. xv. p. 422.
—— —— 11. Between 2 and 3 A.M.	Cove, Aghada, Middleton, and the neighbourhood of the mouth of Cork harbour.	The motion lasted about eight or ten seconds at Cove.		Accompanied at Cove by a rumbling noise. At Aghada the noise was like the firing of cannon. This is doubtless the same event with that reported as having happened on the 6th; but which is the correct date?	Quart. Journ. Roy. Inst. vol. ix. p. 425.

1.	2.	3.	4.	5.	6.
1820. Apr. 17.	Lunröe in Norway	A severe shock			Keilhau.
—— —— 21. $9^h 30^m$ P.M.	Brest	Very sensible motion, apparently from E. to W.		Accompanied by dull explosive noises, lasting but a short time.	Ann. de Chim. et de Phys. t. xv. p. 422.
—— —— 22.	Island of Curaçoa	A severe earthquake			Ditto, t. xxxiii. p. 404.
—— May 4.	Acapulco	Commencement of very violent shocks, which continued almost without interruption until the 10th.			Dupetit-Thouars, Voyage de la Vénus, t. ii. p. 213.
—— —— 7.	Irkutsk	A shock of such violence that the houses could be perceived to lean towards the north (!).			Moniteur, 3 Août.
—— —— 10.	Acapulco		The sea retired from half the bay, leaving the rocks dry. The motion was that of alternate flux and reflux, with an interval of rest at the highest and lowest levels. After two hours the sea returned, and rose to a church on the highest side of the town. When the water retired for the second time the mole was left almost entirely covered with sand, and a greater surface of the bay was exposed. The sea then gradually returned to its natural level.		Dupetit-Thouars, *loc. cit.*

1820. May 20.	Wanlock-head, Dumfries.				D. Milne's Catalogue of British Earthquakes.
—— June 11. $11^h 30^m$ (A.M. or P.M.?).	Gunong-Api in the island of Banda.	An earthquake		Accompanied by volcanic eruption	Garnier, Météor. p. 127.
—— —— —	Lunröe in Norway	A feeble shock			Keilhau.
—— —— 17.	Innspruck	A rather severe shock		Probably only the same with that of July 17	Ann. de Chim. et de Phys. t. xxxiii. p. 404.
—— July 5. $3^h 25^m$ A.M.	Tiflis in Georgia	Two shocks		Accompanied by very violent detonation	Moniteur, 17 Sept.; Ann. de Chim. et de Phys. t. xv. p. 422.
—— —— 17. $7^h 30^m$ A.M.	Innspruck. Also felt at Swatz and the mountain of St. George's.	A strong trembling, lasting four seconds.		Accompanied by a loud cracking noise. Occurred during the celebration of a service in honour of St. Alexis, held in pursuance of a vow made in 1670 on the occasion of a similar phænomenon.	Moniteur, 30 Juillet, 1 et 3 Août; Journ. des Débats, 29 Juillet; Quart. Journ. Roy. Inst. vol. x. p. 199.
—— Aug. 10.	Lunröe in Norway	Four slight shocks			Keilhau.
—— —— 18.	Ditto	Two ditto			Ditto.
—— —— 20.	Ditto	One ditto.			Ditto.
—— —— 21. About 2 P.M.	Island of Curaçoa. Not felt in the Antilles.	A severe shock			Ann. de Chim. et de Phys. t. xv. p. 422.
—— —— —	Lunröe in Norway	Another slight shock.			Keilhau.
—— —— 22.	Ditto	Ditto			Ditto.
—— —— 29.	At sea, between Sicily and the Morea, in lat. 36° 12′.				Férussac, Bull. des Sc. Nat. t. xvii. p. 43.
—— Sept. 14.	Lunröe in Norway	Another slight shock			Keilhau.
—— —— 27. 9 P.M.	Barmouth in Merionethshire.	A shock		Accompanied by noise like that of cannon	Ann. de Chim. et de Phys. t. xv. p. 423.
—— Oct. 10.	Lunröe in Norway	Another slight shock			Keilhau.
—— —— 19.	Honduras, Omba, and St. Pardo.			In St. Pardo the church and many houses were thrown down. The earth opened in many places, some little hills fell into the river, and many people perished.	Ann. de Chim. et de Phys. t. xv. p. 422; Moniteur, 23 Nov.
—— —— 23, 24.	Berne	A slight trembling			M. Studer's Catalogue.
—— —— 28.	Kamtschatka	Several shocks from N. to S. Very violent, lasting altogether three minutes.			Mém. de l'Acad. Imp. de St. Pétersbourg, t. x. p. 40.

1.	2.	3.	4.	5.	6.
1820. Nov. 13. At night.	Marseilles	Several people *believed* that they felt a slight earthquake shock.			Ann. de Chim. et de Phys. *loc. cit.*
—— —— 17. 8h 15m P.M.	Island of Antigua	A shock of rather long duration.			Ditto.
—— —— 18. 7h 40m A.M.	Ditto	Another shock			Ditto.
—— —— 28. 8 A.M.	Leadhills and Wanlockhead in Scotland. Felt 10 miles to E., and 3 or 4 to W.			Felt in the mines. A bed was shaken by the motion, which was attended with a hollow rumbling noise. The atmosphere was perfectly still before the shock.	Tilloch's Magazine, vol. lvi. p. 463; D. Milne's Catalogue of British Earthquakes.
—— —— —— 11h or 11h 30m P.M.	Ditto	Another shock			Ditto.
—— —— 29. 10h 30m (A.M.?).	Ditto	Ditto			Ditto.
—— Dec. 12. 4 A.M.	In the neighbourhood of Innspruck.	A rather severe shock of some seconds' duration.			Moniteur, 26 et 27 Déc.
—— —— About the middle of the month.	In Upper Bavaria, and the northern part of the Tyrol.	A rather severe shock		Probably the same with the last account	Ann. de Chim. et de Phys. t. xv. p. 423.
—— —— 22.	In the Peloponnesus	Trembling		Springs of boiling water came out of the earth in Elis, and rocks fell suddenly in Arcadia.	Soutzo, Hist. de la Révolution Grecque, Paris, 1829, p. 52.
—— —— 25. At night.	Kintail, Loch Earne, &c. in Scotland.				Tilloch's Magazine, vol. lvii. p. 147.
—— —— 29. About 5 A.M.	In the Morea and Ionian Isles, especially in Zante; including a circuit of about 250 leagues.	There seemed to be three shocks, of which the first was vertical, the second undulatory, and the third, the most violent, *was described as rotatory.* The whole lasted 30 seconds to a minute.		The weather had been stormy for some days before. At 4h 10m A.M. there was an extraordinary gust of wind, which suddenly ceased, it became calm, and soon after the earthquake occurred. The shocks were preceded by a dreadful subterranean bellowing noise. After the earthquake the clouds grouped themselves into large masses, and discharged torrents of rain, and hail of such a size that some of the stones weighed ten ounces. On the night of	Journ. de Phys. t. xcii. p. 466; Ann. de Chim. et de Phys. t. xviii. p. 413; Moniteur, 15 Fév. 1821; Gilbert's Annalen, B. lxix. S. 330.

		Direction—S.E. to N.W. Other slighter oscillations followed.		**the 30th there was another terrible storm of rain. The wind remained in the S.E. for twenty-five days after the earthquake. Three or four minutes before the first shock a very large igneous meteor (apparently 4 to 6 feet in diameter) was observed over the sea off Point Geracas, and remained visible for five or six minutes.** On the 30th a luminous meteor described a vast parabola over the town, and fell into the sea. Numbers of houses were thrown down or injured in Zante, but only four men were killed.	
1820. Dec. 29.	Island of Celebes	A severe shock	The sea rose several times to an unusual height, and carried away many houses.	Many hundred people lost their lives	Leonhard's Taschenb. für Mineralog. Jahrg. 18. S. 724; Quart. Journ. Roy. Inst. vol. xii. p. 427.
——	Coquimbo	....	....	The town was nearly destroyed, but the shock was local, and produced no alarm in other parts of the country.	Quart. Journ. Roy. Inst. vol. xvii. p. 39.
1821. Jan. Beginning of the month.	In Portugal..............	Earthquake shocks, *said by some* to have been felt at this time, others however denying the fact.	....	Terrible storms	Moniteur, 9, 10, 11, 12, et 13 Fév.
—— —— 4.	Island of Celebes, especially at Boeloc Comba.	More shocks	....	....	Revue Encycl. 1822, Juin; Archiv. des Découv. 1822, p. 193; Quart. Journ. Roy. Inst. vol. xii. p. 427.
—— —— 6. 6h 45m P.M.	Zante and in the Morea	Several shocks. Much slighter than the former ones; lasted about 80 seconds, apparently in the same direction as before.	On the 9th January the water of the Alcyonic Sea, a part of the Gulf of Corinth, rose suddenly, inundating the country, and carrying away houses.	Much damage done in the villages. The town of Sala in the Morea was almost entirely destroyed by these shocks and those of December, numbers of people perishing beneath the ruins.	Ann. de Chim. et de Phys. t. xviii. p. 413; Moniteur, 9 Avril; Journ. de Phys. t. xcii. p. 466; Soutzo, Hist. de la Rév. Grecque, p. 52.
—— —— 15. 2h 30m A.M.	Berne	A strong shock	....	The Archives des Découvertes (1822, p. 189) gives the date January 14.	Ann. de Chim. et de Phys. t. xviii. p. 414; M. Studer's Catalogue.
—— —— 29. 2 A.M.	Kieff in Russia...........	Rather severe shocks from E. to W.	....	....	Ann. de Chim. et de Phys. t. xviii. p. 414; Archiv. des Découv. 1822, p. 189.

1.	2.	3.	4.	.	6.
1821. Feb. 4. About $1^h 30^m$ A.M.	Bergen in Norway	Rather severe shock, followed by another of a minute's duration at half an hour after noon, and at 8 P.M. by two others with an interval of three or six minutes, the first of which was the most considerable, but was nevertheless slighter than that at 12½. Apparent direction N. to S.			Rigstidenden, 1821, Nos. 15 and 30; Ann. de Chim. et de Phys. *loc. cit.*; Archiv. des Découv. 1822, p. 190.
—— —— — 8 P.M.	Voss in Norway	Two shocks, of which the first was the stronger.			Ditto.
—— —— 6. $7^h 30^m$ P.M.	Ditto	A feeble shock			Keilhau.
—— —— 10. 2 A.M.	Jassy in Moldavia	A perceptible earthquake.		The Mém. de Chronol. (t. ii. p. 935) gives the date February 3–4 for this event, which is said to have been very remarkable, and to have been followed by other shocks in Moldavia in July, August, and September.	Ann. de Chim. et de Phys. *loc. cit.*; Journ. des Débats, 1 Avril.
—— —— —	Kieff in Russia. Also felt at Dubossar.	A shock lasting fifteen seconds at Kieff. Direction E. to W.		Probably only the same event with that reported on the 29th of January.	Ditto.
—— —— 22. $3^h 30^m$ P.M.	Voss in Norway	A very severe shock. The shocks observed at this place appeared to pass from W. to E.			Keilhau.
—— —— End of the month.	Quebec in Canada	A slight shock			Ann. de Chim. et de Phys. *loc. cit.*; Archiv. des Découv. 1822, p. 190.
—— —— ...	In Kamtschatka	Many severe and long-continued earthquake shocks.		Preceding a violent eruption of the volcano Kliutchewskaja-Sopka. During this eruption two-thirds of the cone of Alaid, a small conical island of the Kurile group, fell.	St. Petersb. Zeitschrift, 1825, Märe, p. 333; Férussac, Bull. des Sc. Nat. t. xiv. p. 198.

1821. Mar. 5. 5 A.M.	Island of Martinique	Several shocks		The Archives des Découv. gives the hour 3 A.M.	Ann. de Chim. et de Phys. *loc. cit.*; Archiv. des Découv. 1822, p. 190.
—— —— 9.	Island of Bourbon	A shock of but short duration.		During a violent eruption of the volcano on this island, which began on the 27th of February. The Archiv. des Découv. gives the date of the shock March 19.	Ann. de Chim. et de Phys. t. xxxiii. p. 404.
—— —— 22.	Rieti in the States of the Church.	An extremely severe shock.		At the moment of the shock a column of fire was seen to rise from the Fiume-di-Canera, which passed over the town, and seemed to fall into the lake of Cantelice.	Ann. de Chim. et de Phys. *loc. cit.*; Journ. des Débats, 21 Avril.
—— April 8. $2^h\ 30^m$ P.M.	Melilla in the kingdom of Fez.	A severe shock, followed by other slighter ones.		Accompanied by noise of extraordinary intensity	Ann. de Chim. et de Phys. *loc. cit.*
—— May 9.	Lunröe in Norway	A feeble shock			Keilhau.
—— June 8. 5 A.M.	Island of Martinique	An earthquake		Following a sudden gale of wind, one of those there called "Grains."	Ann. de Chim. et de Phys. t. xviii. p. 414; Arch. des Découv. 1822, p. 190.
—— —— 25. Between 7 and 8 P.M.	In the county of Cork, Ireland.	"Subterranean motion." The shocks were numerous and violent.		Fields were converted into marshes or quagmires	Journ. des Débats, 26 et 29 Juillet.
—— July 25.	Lunröe in Norway	Another slight shock			Keilhau.
—— Aug. 2. $3^h\ 30^m$ A.M.	Naples	A slight shock. Apparently in the direction of the meridian.			Ann. de Chim. et de Phys. t. xviii. p. 414; Tenore, Géogr. Phys. et Botan. du Royaume de Naples, p. 93.
—— —— 3.	Argelès and Lourdes in the departm. Hautes-Pyrénées.	A slight shock			Ann. de Chim et de Phys. t. xviii. p. 414; Archiv. des Découv. 1822, p. 190.
—— —— 20 or 26.	St. Thomas and S^ta^ Croix in the West Indies.	Several shocks. Others were felt for some days before.		About the 20th a fire-ball was seen, the crackling of which could be heard. It vanished without explosion.	Leonhard's Taschenb. für Mineralogie, Jahrg. 18. Abtheilung 3. S. 725; Gilbert's Annalen, B. lxix. S. 223.
—— Sept. 1 to 15.	Catanzaro in Calabria	Frequent shocks			Ann. de Chim. et de Phys. t. xxxiii. p. 405.
—— —— 10.	Lunröe in Norway	A slight shock			Keilhau.
—— —— 12.	Ditto	Ditto			Ditto.
—— —— 17.	Jassy in Moldavia	Another shock		Did much damage to buildings	Ann. de Chim. et de Phys. *loc. cit.*
—— —— 20. 2 A.M.	Könitz near Berne	A trembling			M. Studer's Catalogue.

1.	2.	3.	4.	5.	6.
1821. Sept. 23. 3 P.M.	Albano and Frascati in Italy.	One shock			Ann. de Chim. et de Phys. *loc. cit.*
—— Oct. 6 & several preceding days.	District of Gicastro in Calabria.	Continuous shocks, of which some were very violent.		The town of Catanzaro especially suffered	Gilbert's Annalen, B. lxix. S. 223.
—— —— 7.	Epinal, Remiremont, and Plombière, in the departm. Vosges.	Several shocks from S. to N., lasting thirty seconds.		"Bruit semblable à celui que font entendre, quand elles tournent avec rapidité ces sphères creuses et percées d'un trou que les enfants appellent des *Diables*."	Ann. de Chim. et de Phys. t. xxi. p. 393.
—— —— 8.	District of Orihuela, kingdom of Murcia, Spain.	Commencement of shocks, which lasted twenty-six days.			Ann. de Chim. et de Phys. t. xlv. p. 396; Férussac, Bull. des Sc. Math. Janv. 1831, p. 36.
—— —— 9 or 10.	Strathearn, a few miles east of Crieff, Scotland.			The noise resembled that of a mail-coach on a bad road. A person felt the ground move under his feet, as if it had been a piece of moving bog.	D. Milne's Catalogue of British Earthquakes.
—— —— 11 to 14.	Sienna in Tuscany	Eight or ten shocks daily for this time. Direction = W. to E.		The shocks were constantly felt about midnight and at sunrise.	Gilbert's Annalen, *loc. cit.*; Ann. de Chim. et de Phys. t. xxxiii. p. 405.
—— —— 15. Early in the morning.	Island of Bute, Rothsay, and Greenock, Scotland.	Slight undulatory motion, lasting a few seconds.			Tilloch's Magazine, vol. lviii. p. 458.
—— —— 17.	Sienna in Tuscany	Several shocks, the most severe of which occurred at 8 A.M.			Ann. de Chim. et de Phys. *loc. cit.*
—— —— 18. At night.	Ditto	Five shocks			Ditto; Gilbert's Annalen, *loc. cit.*
—— —— 22. In the morning.	Comrie, Crieff, Loch Earne, Inverary, and at Down, thirteen miles down Loch Fyne, Scotland.	A vibratory shock		Accompanied by noise like that of several carriages in motion. Thunder and lightning at same time.	D. Milne's Catalogue; Ann. de Chim. et de Phys. t. xxi. p. 393; Edinburgh Philos. Journ. vol. vi. p. 191.
—— —— 24. In the morning.	Sienna in Tuscany	The last of the shocks felt about this time.		Followed on the 25th by a thunderstorm	Ann. de Chim. et de Phys. t. xxxiii. p. 405; Gilbert's Annalen, *loc. cit.*
—— —— 28. Between 9^h 30^m and 9^h 45^m P.M.	In Upper Saxony, extending as far as Krottendorf (between Scheibenberg and Schwartz-	One or two undulatory shocks, lasting 15 seconds, or according to some, 2 mi-		A noise was heard like that of three or four carriages rolling after each other, and some people spoke of luminous phænomena seen at the same time. A thick fog prevailed on this day,	Ann. de Chim. et de Phys. t. xviii. p. 414; Gilbert's Annalen, B. lxix. S. 220, 325, 435.

	enberg) on the S., Eitritsch near Leipzig on the N., Mitweida on the E., and Etzdorf near Eisenberg on the W. The principal axis of disturbance seems to have run S.E. and N.W., at right angles to the chain of the Erzgebirge.	nutes.		as well as on those preceding and succeeding. The shock was especially strong on the line between Penig and Wechselburg; and at some places in the area mentioned, as at Zwickau, Chemnitz, and Borna, was not felt at all.	
1821. Oct. 29. In the evening.	Glasgow, Greenock, &c. in Scotland.	A vibration	....	On the same day an unusually thick fog prevailed in London.	Gilbert's Annalen, B. lxix. S. 223.
—— —— 30. 1 P.M.	Annaberg and Schwartzenberg in the Erzgebirge, Saxony.	Vibratory motion, lasting three to five minutes, in the direction E. to W.	....	....	Ditto, S. 329.
—— Nov. 17. 2h 50m P.M.	Lemberg in Gallicia ...	Slight shocks, lasting some seconds.	....	....	Ditto, S. 329 u. 435; Férussac, Bull. des Sc. Nat. t. xvii. p. 343.
—— —— —— 3h 45m P.M. and in some places as late as 4 P.M.	Kieff in Podolia, the other southern governments of the Russian Empire, Jassy in Moldavia, and as far as Tiflis in Georgia.	Three strong shocks..	....	At Jassy some damage was done to buildings; in Kieff the shocks were but slight, but were stronger at Olgopol, Uman, Dubossar (in the government of Cherson), Machnowka, Nikolajew, and Otschakow.	Ditto.
—— —— 22. 2 A.M. At Naples 2h 15m.	In the provinces of Capitanata and Molise, kingdom of Naples, particularly at Tremoli and Porto-Cannone. Felt but feebly at Naples.	A strong shock from E. to W., followed, rather slowly, by seven others.	....	A luminous meteor moving in the same direction as that taken by the shock was observed just before. At Tremiti and elsewhere some damage was done to buildings, &c. The autumn had been dry, and since the middle of October, cold. On the 5th November there was a violent storm.	Gilbert's Annalen, B. lxix. S. 436; Tenore, *loc. cit.* p. 93; Ann. de Chim. et de Phys. t. xxxiii. p. 405; Journ. des Débats, 13 et 27 Déc.
—— —— 27. 8 A.M.	Leadhills and Wanlockhead, Scotland.	A slight shock, followed, at 11 P.M., by another shock, unaccompanied by trembling motion.	....	Accompanied by a hollow rumbling noise, heard distinctly by the miners at a depth of 150 fathoms. The noise was still louder on the occurrence of the second shock.	D. Milne's Catalogue.
—— —— 29.	Odessa	Vibratory. Lasting about forty seconds.	The sea rose higher than usual.	Probably only the same event with that of the 17th, the difference of style accounting for the different dates.	Gilbert's Annalen, *loc. cit.* S. 329; Ann. de Chim. et de Phys. t. xxxiii. p. 405.

1.	2.	3.	4.	5.	6.
1821. Dec. 16. 7h (A.M. or P.M.?).	Prague	Several considerable shocks.	....	....	Gilbert's Annalen, *loc. cit.* S. 436.
—— —— 20.	In Iceland	The earth trembled strongly.	....	During the violent eruption of the volcano Eyafields-Jokull, which began on the 19th, continued with great violence for many days, and had not ceased on the 28th of February, 1822. On the 25th of December there was a violent storm from the south, and on the 26th and 27th from the north-east; accompanied by an unusually low state of the barometer, observed over a great part of Europe.	Ann. de Chim. et de Phys. t. xxxi. p. 397; Journ. des Débats, 8 et 9 Avril, 1822; Edinb. Philos. Journ. vol. vii. p. 155, &c.
—— —— 24.	Rhintal (Rheinthal?), Switzerland.	A shock	....	Preceded by the appearance of several luminous meteors.	Ann. de Chim. et de Phys. t. xxxiii. p. 405.
—— —— 25. 8h 30m P.M.	Mayence	A slight shock..........	....	On the same day a violent tempest raged at Genoa, in Upper Italy, and in Switzerland. A remarkable fall of the barometer was also observed over almost the whole of Europe.	Ditto, t. xxi. p. 393; Edinb. Philos. Journ. vol. vii. p. 155.
—— —— 26. After midnight (of the 25th?).	On the coast of the Adriatic (east or west coast?).	Two strong shocks ...	....	....	Ann. de Chim. et de Phys. t. xxxiii. p. 405.
——	Bima in the island of Sumbava, principally under the sea.	At Bima the shocks occurred at regular intervals of five or six minutes.	The earthquake under the sea off Bima was tremendous, ships being carried by the "sea-wave" inland even over houses. The commotion extended to the coasts of Celebes and Macassar.	At the same time with the shocks a submarine volcano near Bima threw out burning stones, ashes, and thick smoke.	Reinwardt in Magaz. voor Wetensch. Konst en Lett. p. v. H. 1. p. 71.
1822. Jan. 9. About 8 P.M.	At Naples	A slight vibratory shock from E. to W.	....	....	Tenore, *loc. cit.* p. 94.
—— —— 19.	Salerno in Italy	Two slight shocks, one in the day, and one at night.	....	On the 13th of February an eruption of Vesuvius began, which ceased on the 25th; though ashes continued to be thrown forth almost the whole summer through, and the eruption recommenced with great violence on the night of the 24th of November.	Ann. de Chim. et de Phys. t. xxxiii. p. 405, t. xxi. p. 398.

	in Hungary				Férussac, Bull. des Sc. Nat. t. xviii. p. 195, quoting from Michael Holeczy, Tudomanyos Gyiytemény, 1824, Nr. v. p. 56–61.
—— Feb. 6.	Ditto				Ditto.
—— —— 8.	Landshut in Bavaria	Five shocks in less than 80 seconds.			Ann. de Chim. et de Phys. t. xxi. p. 393.
—— —— 15.	Halland in Sweden	A severe shock			Ditto, t. xxxiii. p. 405.
—— —— 18.	Komorn in Hungary	Ditto. Of but short duration.	The waters of the Danube were much agitated, and threw up abundance of a red sand upon the shores.	Preceded by a very loud noise, which seemed to come from the air.	Ditto.
—— —— 19. 8h 15m A.M. At Lausanne at 9h 15m. At Berne 9h.	In France and Switzerland. Felt at Belley, Dijon, Clermont, Lyons, Bourg, Geneva, Lausanne, Berne, Zurich, Chambery, Annecy, Albi, and at Aix.	Violent. At Paris the direction is said to have been that of the magnetic meridian, as observed by the motion given to a magnetic needle, or S.S.E. to N.N.W. At Geneva the horizontal oscillation felt in the upper stories was from N.E. to S.W. At Seyssel and Belley the shock was very strong, and lasted twelve or fifteen seconds.		At Belley rocks were split by the shock. At Aix the hot springs were troubled, and lost their taste and smell. At Chambery many old walls were cracked. At Geneva a dull noise like the rolling of wagons was heard. The barometer, which before was high, rose slowly all the forenoon. For Arago's account of the disturbance of the magnetic needle at Paris, vid. Ann. de Chim. et de Phys. t. xix. p. 106.	Journ. des Débats, 25 Fév. et 7 Mars; Ann. de Chim. et de Phys. t. xix. p. 106 et 185, t. xxi. p. 393; M. Studer's Catalogue.
—— —— 22.	Komarom in Hungary				Férussac, *loc. cit.*
—— —— 23.	Ditto				Ditto.
—— —— —— 3h 35m P.M. At Chambery at 3h 43m.	Belley in the departm. de l'Ain. Also felt at Chambery.	A single shock			Journ. des Débats, 5 Mars; Ann. de Chim. et de Phys. t. xxi. p. 393; M. Perrey's Memoir on Earthquakes in France, Belgium, and Holland.
—— —— 24.	Komarom in Hungary				Férussac, *loc. cit.*
—— —— 26.	Ditto				Ditto.

1.	2.	3.	4.	5.	6.
1822. Feb. 27.	Komarom in Hungary...	....	....	....	Férussac, *loc. cit.*
—— —— 28.	Ditto	....	....	....	Ditto.
—— March 1.	Ditto	....	....	....	Ditto.
—— —— 3.	Ditto	....	....	....	Ditto.
—— —— —— $6^h\ 30^m$ P.M.	Bassano in Italy	A slight shock.........	....	....	Ann. de Chim. et de Phys. t. xxxiii. p. 405.
—— —— 20. At night.	Several villages near York.	....	....	Attended with a rumbling noise	Gentleman's Magazine, vol. xcii. pt. 1. p. 365.
—— —— —— or, according to others, the 12th or 21st March.	Island of Meleda, not far from Ragusa.	Commencement of the noises heard at this place, but which do not seem to have been accompanied by any true earthquake shocks, or, at least, any such felt were extremely slight.	On the 22nd a submarine eruption was supposed to have occurred near Marsala in Sicily. Journ. des Débats, 23 Avril.	The noises were heard at the following periods:—March, April, May, June, July and August, 1822; March, April, July, August, September, October, and November, 1823; January, March, April, May, August, September, October, November, and December, 1824; January and February, 1825.	L. Stulli, Sulle Detonacione dell' isola di Meled, Ragusa, 1823; Paul Partsch, Bericht über das Detonations Phænomen auf der Insel Meleda bai Ragusa, Wien, 1826.
—— April 5.	Country around Etna ...	Several shocks	....	Accompanying the commencement of an eruption. Subterranean explosions were heard.	Ferrara, Edinburgh Journal of Science, Nrs. 7 and 8.
—— —— 6.	Ditto; especially the towns of Nicosia, Capizzi, Cesaro, Sperlinga, Troina, Gangi, and Gagliano. The centre seemed to be Nicosia.	Severe shocks	....	The eruption did not cease until October.........	Ditto; Ann. de Chim. et de Phys. t. xxxiii. p. 405.
—— —— 8.	Komarom in Hungary...	....	....	....	Férussac, *loc. cit.*
—— —— 10.	Nicosia and the towns near Etna.	Another shock, more violent than those of the 6th.	....	A violent clap of thunder was heard while the sky was quite clear.	Ferrara, &c. as quoted above.
—— —— 13. 9 or $9^h\ 30^m$ A.M.	Comrie in Perthshire ...	The most violent shock felt for twenty years.	....	Accompanied by two loud reports, the one over head, and the other, immediately after, apparently under foot. The noise lasted thirty seconds, and was louder than any thunder.	Milne's Catalogue; Ann. de Chim. et de Phys. t. xxxiii. p. 406.
—— —— 18.	Catania in Sicily	Slight shock	....	....	Ann. de Chim. et de Phys. *loc. cit.*
—— —— 19. $3^h\ 35^m$ (A.M. or P.M.?).	Ditto	Ditto	....	....	Ditto.

1822. Apr. 22. 9^h 30^m A.M.	Dunkeld in Scotland				D. Milne's Catalogue.
—— —— 23.	Komarom in Hungary				Férussac, *loc. cit.*
—— May 3.	Ditto				Ditto.
—— —— 4.	Lunröe in Norway	A shock			Keilhau.
—— —— 6.	Sicily	Shocks			Hesperus, 1823, Nr. 173.
—— —— 7. 11 P.M.	Carthago in the province of Costa-Rica, Central America, 9° 30′ N. lat.	Violent shocks		The town was quite ruined	Journ. de Frankfort, 1823, Nr. 39.
—— —— 8. At night.	Island of Cuba	A shock of 30 seconds' duration.			Ann. de Chim. et de Phys. t. xxxiii. p. 406.
—— —— ——	Sicily	Shocks			Hesperus, 1823, Nr. 173.
—— —— ——	Lunröe in Norway	Another shock			Keilhau.
—— —— 9. 6^h 58^m A.M.	Czernowitz in Gallicia	Direction = S.E. to N.E. (!). Duration, 2 or 3 seconds.		Accompanied by a noise like thunder	Journ. des Débats, 10 Juin.
—— —— ——	Sicily				Hesperus, 1823, Nr. 173.
—— —— 10.	Ditto				Ditto.
—— —— 18. Between 9 and 10 A.M.	Crieff and the neighbourhood, Scotland.	Severe shocks			Ann. de Chim. et de Phys. *loc. cit.*
—— —— 22.	Komarom in Hungary				Férussac, *loc. cit.*
—— —— 31. 8 A.M. At Cognac between 7 & 8, at Nantes at 7^h 53^m, at Rennes at 7^h 55^m, at Tours and Bourbon-Vendée at 7^h 35^m, at Laval at 8^h 2^m.	In France, at Cognac, Angers, and Tours, and more feebly at Bourbon-Vendée, Laval, and Nantes. Perceived at Paris by the motion of the magnetic needle.	The direction at Paris seemed to be perpendicular to the magnetic meridian; N.N.E. to S.S.W. at Nantes; E. to W. at Tours; N.W. to S.E. at Bourbon-Vendée; three shocks from S.E. to N.W. at Laval.		At Bourbon-Vendée a dull noise was heard like the rolling of a heavily-laden wagon over an uneven road.	Archiv. des Découv. 1823, p. 187; Journ. des Débats, 6 Juin; Ann. de Chim. et de Phys. t. xxi. p. 393; France Pittoresque, t. ii. p. 100.
—— June 16. 4^h 15^m, and 4^h 30^m P.M.	Cherbourg and the neighbourhood.	Two very severe shocks.		Immediately after the shocks a luminous meteor was observed, which seemed to rise from the Bay of Mont-St.-Michel to the south, and was followed by a loud explosion. Torrents of rain fell the same day in the whole department de la Manche, and a waterspout passed over it.	Ann. de Chim. et de Phys. t. xxi. p. 393 et 403.

1.	2.	3.	4.	5.	6.
1822. June 29.	Komarom in Hungary...	....	....	....	Férussac, *loc. cit.*
—— July 1.	Ditto	....	....	....	Ditto.
—— —— 6. 6h 45m (A.M. or P.M.?).	Lisbon	A violent shock, lasting 6 or 7 seconds. The oscillation was rather vertical than horizontal.	....	The Archives des Découvertes gives the date July 10.	Ann. de Chim. et de Phys. t. xxi. p. 393.
—— —— 10. One hour after sunset.	Ancona	....	....	Accompanied by loud explosive noise. On the 11th at dawn an eruption of Vesuvius began.	Ditto, t. xxxiii. p. 405.
—— —— 14.	Catanzaro in Calabria...	A rather severe shock.	....	....	Ditto.
—— —— 15.	Komarom in Hungary...	....	....	....	Férussac, *loc. cit.*
—— —— 22.	Ditto	....	....	On the 23rd, at 6 A.M., a violent eruption of the volcano Gunung-Ber-Api in Sumatra.	Ditto.
—— —— 25.	Ditto	....	....	....	Ditto.
—— —— 28, 29. Midnight.	In several quarters in Madrid.	A slight vibration ...	....	....	Journ. des Débats, 9 Août; Ann. de Chim. et de Phys. t. xxi. p. 393.
—— —— 29. 1 A.M.	Granada in Spain	A violent earthquake; the shocks were renewed on the following night.	....	Many buildings were injured, among others the tower of the cathedral.	Ditto; Archiv. des Découv. 1823, p. 187.
—— —— 30.	Catanzaro in Calabria...	A slight shock	....	....	Ann. de Chim. et de Phys. t. xxxiii. p. 405.
—— Aug. 1. 8 P.M.	Island of Martinique ...	Ditto. None had been felt for two years before.	....	....	Ditto, t. xxi. p. 393; Archiv. des Découv. 1823, p. 188.
—— —— 8. 3h 15m A.M.	Laybach in Carinthia ...	A rather severe shock.	....	....	Ann. de Chim. et de Phys. t. xxxiii. p. 406.
—— —— — 7h 10m P.M.	Tomsk in Siberia	A violent shock from N. to S., lasting one minute.	....	....	Ditto, t. xxi. p. 393; Journ. des Débats et Moniteur, 11, 12 et 13 Nov.
—— —— 9.	Komarom in Hungary...	....	....	....	Férussac, *loc. cit.*
—— —— 10.	Aleppo	Beginning of the shocks.	....	....	Ann. de Chim. et de Phys. t. xxi. p. 393, et t. xxx. p. 433; Moniteur, 5 Oct., 13 Nov., 1 Janv.; Journ. des Débats, 2, 4 Oct., 25 Nov. et 31 Déc.; Vernier, Journ. des Voyages, t. xvi. pp. 6 et 395, et t. xxiv. p. 224.

1822. Aug. 12.	Komarom in Hungary ..	....	....	....	Férussac, *loc. cit.*
—— —— 13. 8 P.M.	Aleppo. Also felt at Beyrout and Alexandria.	A violent earthquake. The worst shocks were at $8^h\ 30^m$, but they recurred more or less every quarter of an hour up to noon on the 14th. On the 15th and 16th there were others, and some occurred almost every day during a month.	Between Alexandria and Cyprus, in long. 28° 35′ E. (from Paris), and lat. 34° 28′ N., a rock appears to have risen from the sea.	Accompanied by subterranean noise, which increased up to 8½ P.M. A large part (two-thirds) of the town was destroyed, and several thousand of the inhabitants perished beneath the ruins. Antioch, Latakiah, Djesr, and other towns within a radius of 50 leagues, were also much injured. The weather had been very hot and close at Aleppo.	Ann. de Chim. et de Phys. &c., as just quoted.
—— —— 21.	Komarom in Hungary ..	....	....	....	Férussac, *loc. cit.*
—— —— 22.	Ditto	....	....	....	Ditto.
—— —— 25.	Ditto	....	....	....	Ditto.
—— —— 28. $10^h\ 40^m$ A.M.	Venice	Slight shocks	....	During serene weather	Ann. de Chim. et de Phys. t. xxxiii. p. 405; Journ. des Débats, 17 Sept.
—— —— 29. $3^h\ 45^m$ (Italian time?)	Ditto	Ditto	....	....	Ditto.
—— —— 30. 1 P.M.	Agram in Croatia	Vibratory shock, lasting five seconds.	....	The shock was more perceptible in the mountains which surround the town from W. to N. Accompanied by subterranean noise like thunder.	Journ. des Débats, 17 Sept.
—— Sept. 4. $8^h\ 55^m$ A.M.	Port of Spain, island of Trinidad.	A rather violent earthquake.	....	....	Moniteur, 23 Oct.
—— —— 5.	Aleppo	More shocks	....	Destroyed what had resisted the former earthquake. More than 20,000 persons are said to have lost their lives by these shocks, which were felt in several other towns, at Damascus, and in the island of Cyprus.	Authorities quoted under Aug. 10.
—— —— 10. $11^h\ 30^m$ P.M.	Karlstadt in Wermeland, Sweden. Felt as far as the extremities of the province.	A strong earthquake shock, from E. to W.	....	Preceded by a noise like that of a cannon, and accompanied by the appearance of a number of very brilliant shooting stars. Aërolites said to have been found in various places.	Ann. de Chim. et de Phys. t. xxi. p. 393; Moniteur et Journ. des Débats, 11 Oct.; Keferstein.
—— —— 13.	Komarom in Hungary ..	....	....	....	Férussac, *loc. cit.*
—— —— 18. Between 1 and 2 A.M.	Dunston near Newcastle-on-Tyne.	A severe shock	....	Accompanied by a loud noise like distant thunder.	Quart. Journ. Roy. Inst. vol. xiv. p. 450; Ann. de Chim. et de Phys. t. xxi. p. 393; Journ. des Débats, 12 Nov.; Moniteur, 13 Nov.

1.	2.	3.	4.	5.	6.
1822. Sept. 29. 5h 56m A.M.	Cadiz. Also felt at Algesiras and Cordova.	A strong shock from E. to W., lasting nearly 2 seconds.	....	....	Ann. de Chim. et de Phys. *loc. cit.*; Journ. des Débats, 15 Oct.
—— —— —	Aleppo	Several more shocks .	....	....	Ann. de Chim. et de Phys. t. xxxiii. p. 406; Journ. des Débats, 16 Déc.; Moniteur, 17 Déc.
—— —— 30. 1st hour of the night.	Ditto	Ditto	....	....	Ditto.
—— —— ...	Between the volcanos Gunung-Ber-Api and Gunung-Tallang, in the province of Menangkabon, island of Sumatra.	The shocks were felt hourly during 24 hours.	....	Accompanied by subterranean noise, which sometimes seemed to come from the one volcano, and sometimes from the other. Tallang gave forth smoke, but no eruption had been known to occur for a long time.	Asiatic Journal, 1826, May, p. 577.
—— Oct. 1.	Mies in Bohemia and neighbourhood.	A very distinct shock.	....	On the 8th there was a most violent eruption of the volcano of Galong (or Galung Gunung) in the island of Java.	Froriep's Notizen, &c. B. iii. No. 58.
—— —— 8.	In Murcia, Spain	Several shocks	....	....	v. Hoff.
—— —— 18.	Country around Vesuvius; at Naples.	....	....	Some motion of the earth gave notice of an eruption which began on the 22nd, at 2 P.M. The shower of ashes ceased on the 25th, and the last appearance of smoke was seen on the 4th November. Stromboli and Vulcano also showed unusual signs of activity.	Wiener Zeitung, 1823, Mai, S. 529; Geist der Zeit. Jul. 1823, S. 123; Férussac, Bull. des Sc. Nat. t. i. 1824, p. 115; Moniteur, 10 Nov.; Journ. des Débats, 12 Nov.
—— Nov. 1.	Norrdelge and all the northern coast of the Baltic.	A slight shock	....	Accompanied by rolling noise	Keferstein, p. 342; Keilhau.
—— —— 4.	Copiapo in Chili	A severe shock	....	Many houses injured	Quart. Journ. Roy. Inst. vol. xvii. p. 39.
—— —— 5.	Ditto, and at Coquimbo.	A much more violent earthquake.	....	Copiapo was nearly destroyed, and Coquimbo also suffered considerable injury.	Ditto.
—— —— —	Komarom in Hungary ..	....	....	....	Férussac, Bull. des Sc. Nat. t. xviii. p. 195.
—— —— During the first half of the month.	Aleppo	Severe shocks felt almost daily. On the night of the 12th a very violent one.	....	....	Ann. de Chim. et de Phys. t. xxi. p. 393; Moniteur, 16 Fév. 1823.

1822. Nov. 19. 10h 15m P.M., or a little after.	In Chili. Felt as far south as Concepcion, and eastward of the Andes at Mendoza and St. Juan. The centre of disturbance was probably about 15 miles N.E. of Valparaiso.	Very violent shocks, lasting 3 minutes. A few minutes later the earthquake recommenced, and from this time shocks were felt almost the whole night, two or three every five minutes, each lasting half a minute or a minute. The first three shocks were by far the most severe. During the violent shocks it seemed as if the earth were raised up and moved from N. to S., and then sank again, but occasionally a movement at right angles to this was also felt. At Santiago and Valdivia the earthquake was less severe. To the N. of Valparaiso the shocks seemed to come from the S.W., while S. of that place they appeared to be from the N.W. Shocks were felt occasionally up to the end of Sept. 1823.	The effect seemed to people on board the ships in the harbour of Valparaiso, as if they were rapidly forced through the water and then struck the ground. The sea here rose to an amazing height, and then retreated so far that all the small boats were left dry upon the strand. It continued rising and falling, though to a gradually diminished extent, for a quarter of an hour. The earthquake was also felt on board ships lying at Callao.	The atmosphere was perfectly clear and fine, and the moon shone brightly. The shocks were accompanied by noise like the bursting forth of vapour. The greater part of the towns of Valparaiso, Melipilla, Quillotoa and Casabianca was ruined. In the morning the streams and lakes were found greatly swollen by the snow which had fallen from the mountains. The water of the lake Quintero, which is connected with the sea, was much lowered. In the valley of Viña a la Mar the earth was covered with heaps of sand 3 or 4 feet high, which had been thrown up mixed with water from holes beneath. Cracks opened in the granite of the promontory of Quintero *parallel to each other and to formerly existing and similar ones.* Some examples of apparent vorticose motion were recorded. In the mine of El Bronze de Peteroa and in several others the shocks were violently felt. The most remarkable concomitant of this earthquake was the permanent elevation of the land for more than 100 miles along the coast. At Valparaiso the elevation was about three feet, and at Quintero four. It seems probable that this coast had been several times before raised in the same way.	Trans. Geol. Soc. 2nd series, vol. i. pt. 2. p. 413; Leonhard, Zeitschrift für Mineralogie, 1825, B. i. S. 255; Quart. Journ. Roy. Inst. vol. xvii. p. 39.
—— —— 20.	Ditto, and at Valparaiso	Three severe shocks; before 2 A.M., about	....	The day and night were hot and windy	Trans. Geol. Soc. *loc. cit.*

1.	2.	3.	4.	5.	6.
		4, and a quarter before 6 A.M. The earth trembled constantly between these shocks.			
1822. Nov. 21.	Chili, and at Valparaiso	At $2^h\ 30^m$, $2^h\ 50^m$, $7^h\ 45^m$, $9^h\ 15^m$, and $10^h\ 15^m$ A.M., and at $1^h\ 15^m$ and 2 P.M., severe shocks were felt.	....	The day and night were hot and windy	Trans. Geol. Soc. *loc. cit.*
—— ——	Horb in Würtemberg ...	A shock	....	....	Hesperus, 1822, 3 Dec.
—— —— 22.	Valparaiso	At $4^h\ 30^m$, $7^h\ 30^m$, and $9^h\ 15^m$ A.M., strong shocks. A little before 10 A.M. three loud explosions, after each of which the earth trembled. At 11 A.M. another severe shock, and between this and 1 P.M. three weak ones. The earth then remained quiet until $7^h\ 30^m$ P.M.	....	On this day there was a thick fog with cold fine rain.	Trans. Geol. Soc. *loc. cit.*
—— —— 23.	Ditto	The shocks were slight, and at greater intervals than before.	....	....	Ditto.
—— —— 24.	Ditto	The earth shook violently up to 11 P.M.	....	....	Ditto.
—— —— 25. 3 and 5 A.M.	Sulz in Würtemberg. Also felt at Altenseig and Heidelberg.	Two shocks	....	Accompanied by subterranean noise like thunder. v. Hoff gives the date Nov. 23.	Ann. de Chim. et de Phys. t. xxi. p. 393, t. xxxiii. p. 406; Moniteur, 8, 12, 13 Déc.; Journ. des Débats, 6 Déc.
—— —— ——	Valparaiso	At $8^h\ 15^m$ A.M. a severe shock, followed by others till shortly before 10.	....	....	Trans. Geol. Soc. *loc. cit.*

1822. Nov. 26.	Ditto	At $2^h 45^m$ A.M. a perceptible vibration, lasting nearly 2 min. From this time till the 18th Jan. 1823, shocks of more or less violence were daily felt. Those of the 10th and 25th December were the most severe.		On the evening of the 27th the country was visited by a tremendous storm of rain, accompanied by heavy gusts of wind, a meteorological phænomenon never before known to occur at this season; hence great terror was caused by it.	Ditto; Quart. Journ. Roy. Inst. vol. xvii. p. 44.
—— —— 28. $10^h 50^m$ A.M.	Tübingen, Heidelberg, Strasburg, Kohl, Buol, Steinbach, Einzheim, Carlsruhe, Spires, and Stuttgart.	A rather strong shock. At Stuttgart the direction was *S.E. to N.E.*		Herr v. Yelin (at Munich?) believed that the magnetic needle was affected by this earthquake.	Ann. de Chim. et de Phys. &c., quoted for the 25th; Hespérus, 1822, 3 Déc.; Schweigger, B. liii. (xxiii.) S. 49.
—— —— — About half-an-hour after midnight?.	Mayence, especially on the bank of the Rhine.	A perceptible shock			Ditto.
—— Dec. 1.	Island of Grenada in the West Indies.	A violent earthquake.		Did great damage to buildings	Ann. de Chim. et de Phys. t. xxiv. p. 429; Archiv. des Découv. 1824, p. 210.
—— —— 20.	Ditto	More shocks		Enormous rocks were rolled down from the mountains.	Ditto.
—— —— 24.	Komarom in Hungary				Férussac, Bull. des Sc. Nat. t. xviii. p. 195.
—— —— 27. About 9 P.M.	Kadu in the island of Java.	Shocks, which continued for 30 hours.			Asiatic Journal, 1822, Dec.; Verneur, Journal des Voyages, t. xviii. p. 260; Férussac, Bull. des Sc. Nat. 1824, p. 328.
—— —— 28.	Ditto	A more violent shock felt.			Ditto.
—— —— 29. $1^h 30^m$ A.M.	The mountain Brome, at Passuruan in Java.	The mountain was many times violently shaken internally.		A shower of fine black ashes was thrown forth from this mountain. At the same time Merapi was in violent eruption. Four villages were burnt by the lava. The district of the island which had been convulsed on the 8th October, now remained perfectly quiet.	Ditto.
1823. Jan. 6.	Bergen in Norway				Keferstein.
—— —— 9.	Lunröe in Norway	One shock			Keilhau.

1.	2.	3.	4.	5.	6.
1823. Jan. 10.	Lunröe in Norway	Three shocks			Keilhau.
— — —	District of Orihuela in Murcia, Spain. The shocks were felt at Carthagena and Alicant.	More than 200 severe shocks in 24 hours.		Several houses fell	Ann. de Chim. et de Phys. t. xlv. p. 396; Férussac, Bull. des Sc. Math. Janv. 1831, p. 36.
— — 15. 6 P.M.	Santiago in Chili	Severe tremblings			Garnier, Météorologie, p. 136.
— — 24.	Lunröe in Norway	One shock			Keilhau.
— — 25.	Ditto	Two shocks			Ditto.
— — 27.	Ditto	One slight shock			Ditto.
— — 29.	Norrdelge, a town to the east of Upsal in Sweden.	An earthquake		Probably the same with the following	Ditto.
— — 30. In the island of Aland between 11 P.M. and midnight.	Ditto, and in the island of Aland in the Baltic, 11 geographical miles from Norrdelge.	At Norrdelge two shocks. In Aland one violent one.		In Aland accompanied by a subterranean noise.	Ann. de Chim. et de Phys. t. xxiv. p. 429; Journ. des Débats, 17 Mars; Moniteur, 18 Mars; Poggendorff's Annalen, B. ix. S. 592.
— — ...	Rasipatz or Karipatz, a post station between St. Petersburg and Riga.	A rather severe shock, followed, it appears, by another in February.			Ann. de Chim. et de Phys. t. xxxiii. p. 406; Journ. des Débats, 17 Mars.
— — ...	In Chili	Six shocks		Perhaps the same with the earthquake mentioned on the 15th.	Ann. de Chim. et de Phys. t. xlii. p. 407.
— Feb. 9. 1 P.M.	Columbo in Ceylon. Also felt at Kandy, Ratnapora, Matura, and Negumbo.	In Ceylon two shocks in half-a-minute.	At 1^h 10^m P.M. the ship 'Winchelsea,' in lat. 1° 21′ N., long. 85° 35′ E., experienced a severe shock. The motion was tremulous, as if the vessel were passing over a coral reef. At the same time a loud rumbling noise was heard, like the rolling of a butt on deck. The agita-	Accompanied by subterranean noise like that of a cannonade. The Quart. Journ. gives the position of the 'Winchelsea' as 52° N. lat., 85° 33′ E. long., a manifest error. Before the shock an unusual oscillation of the barometer on board this ship, to the extent of ·1 in., was observed. Since the afternoon of the 8th the mercury had fallen from 30·5 in. to 30 in. It rose again to its former level on the 11th. v. Hoff suggests a *possible* connexion between this earthquake and that in Moldavia on the same day.	Tilloch's Magazine, Jan. 1824, p. 24; Férussac, Bull. des Sc. Nat. 1824, t. i. p. 326; Edinburgh Journal of Science, 1826, April, p. 264; Quart. Journ. Roy. Inst. vol. xvi. p. 184; Monthly Magazine, vol. lviii. p. 530; Edinburgh Journal of Science, vol. iv. p. 261.

			tion and noise continued two or three minutes. No commotion was visible in the water. At 1h 15m the ship 'Orpheus,' in 1° N. lat., 84° 6′ E. long., felt a shock as if the vessel had touched the bottom. A confused grinding tremulous noise was heard for 60 or 65 secs. No ground on sounding with 20 fathoms. The shock was sufficiently strong to throw one of the compasses out of its place. At 2h 5m, in 1° 15′ N. lat. and 84° 4′ E. long., a second slighter shock was felt, and about 3h a third, scarcely perceptible.		
1823. Feb. 9. 6h 50m P.M. (At Jassy between 6 & 7.)	Bucharest and Jassy in Moldavia.	Violent shocks	....	The earthquake is also reported as on the 10th at Jassy, but there is little doubt that the event is the same with that at Bucharest.	Ann. de Chim. et de Phys. t. xxiv. p. 429; Archiv. des Découv. 1824, p. 210.
—— —— 16.	Palermo	One shock	....	....	Poggendorff's Annalen, B. xxiv. (c.) S. 54.
—— —— 19. 6 P.M.	Belley in the departm. Ain.	Very perceptible shocks.	....	....	Ann. de Chim. et de Phys. t. xxxiii. p. 406.
—— —— Night between 24 and 25.	Salzgitter, near Hildesheim near Hanover.	Some people *believed* that they felt motion like that of an earthquake.	....	During a violent storm. The supposition that earthquake shocks were felt is somewhat confirmed by the fact, that an opening of a foot in width was observed next morning in the	Hespérus, 1823, Nr. 109. S. 436.

1.	2.	3.	4.	5.	6.
				street at the west end of the town, beneath which was a deep hollow. The opening gradually increased in width, but, by the falling in of earth, was closed below.	
1823. **Feb. 25.**	Lunröe in Norway	Two shocks	....	....	Keilhau.
—— —— **27.**	Foggia, San Severino, &c. in Apulia.	Severe shocks	....	....	Ann. de Chim. et de Phys. t. xxiv. p. 429; Moniteur, 28 Mars.
—— **Mar. 2.**	Madras and in Ceylon...	A severe shock, felt 20 minutes later at Travancore than at Madras.	....	....	Archiv. des Découv. 1824, p. 210; Ann. Reg.
—— —— 5. 5h 26m P.M.	In Sicily. Very violent at Palermo. Several less severe shocks were felt from Cap-di-Orlando to Cap-di-Calava. At Catania, Syracuse, and Trapani, and in general in the interior and south of the island, but little motion was perceived. At Alcamo, however, eight leagues to the E. of Trapani, the shock was very strong. At Stromboli and Lipari the earthquake was very violent, and the centre of disturbance was probably about here.	Very violent. Five shocks at Palermo, lasting together 16 or 17 secs. Direction N.E. to S.W. The first shock was indistinct, but tending from below upwards; the second was more severe, and undulatory; the third less strong, but of the same nature; the fourth was on the whole equal to the second; and the fifth, like the first, had an evident tendency upwards. At Caltanisetta five shocks, from N.E. to S.W., were felt in 9 secs. At Terrapilata the direction was S.E. to N.W., and the ground rose 10 feet. At Milazzo a shock	At Cefalu, 48 miles from Palermo, the waters of the sea came in in two successive waves of enormous size, and destroyed a building.	At Palermo the water in the great basin of the botanical garden was raised up in the direction of S.W., and the mercury in the seismometer at the Observatory was put into violent motion, so that at the fifth shock it seemed as if boiling. The spear of a vane on the palace bowed to the S.W. at an angle of 20°, and remained so until the 9th, when it fell. A palm-tree, 30 feet high, was seen to bow its branches alternately to N.E. and S.W., almost to the ground. The clocks of the Observatory which vibrated from N. to S. and from E. to W. were stopped, and the actuating weight of one of them broke its crystal. Two small clocks vibrating in the direction of the shock were not stopped. Great damage was done at Roccapalombo, Pozzillo, S. Agata, Isnello, Castel-Buono, &c., and especially at Naso. The warm springs of Termini were troubled. At Terrapilata clefts of 10 to 18 in. wide opened, and an eruption of mud and gas took place from the two mud volcanos. At Palermo the following night was stormy, with rain, thunder, snow, and hail.	Silliman's Journal, vol. ix. p. 216; Ann. de Chim. et de Phys. t. xxiv. p. 429; Moniteur, 28 Mars et 28 Déc.; Journ. des Débats, 31 Mars et 1 Avril; Férussac, Bull. des Sc. Nat. t. iv. pp. 7–9, t. v. p. 406, t. xiii. p. 33; Ferrara, Memoria sopra i tremuoti della Sicilia in Marzo 1823, Palermo, 1825; Edinb. Journal of Science, no. vii. p. 155, no. viii. p. 362.

		was felt at night in the direction of Stromboli and Vulcano, not perceived at Palermo.			
1823. Mar. 6. 1^{h} 45^{m} A.M.	S^{ta} Lucia-di-Milazzo in Sicily, 6 miles from the shore. Also felt at Messina, but not at Palermo.	Violent shocks, recurring four times.	....	Accompanied by terrible noise	Ditto.
—— —— 7. 10^{h} 56^{m} P.M.	Palermo	Another shock, from N.E. to S.W.	....	....	Ditto.
—— —— 9.	In North-Eastern India, especially in the Neilgherry mountains. Also felt at Madras, though with less violence.	....	....	....	Asiatic Journal, 1823, Oct. p. 376; Férussac, Bull. des Sc. Nat. 1824, t. i. p. 326.
—— —— —	San Severino in Italy ...	A slight shock........	....	....	Ann. de Chim. et de Phys. t. xxxiii. p. 406.
—— —— 10.	Ditto	Ditto	....	....	Ditto.
—— —— 11.	Ditto	Ditto	....	....	Ditto.
—— —— 19.	Lunröe in Norway	Two shocks............	....	....	Keilhau.
—— —— 24.	Ditto	Two more strong shocks.	....	....	Ditto.
—— —— 26.	Palermo	Some more slight shocks.	....	....	Ferrara's memoir above quoted.
—— —— 27.	Island of Favignana, near Trapani, Sicily.	Strong trembling	....	Part of an ancient fortress fell, and twenty-two persons perished.	Ann. de Chim. et de Phys. *loc. cit.*
—— —— 31. 2^{h} 52^{m} P.M.	Messina	Slight vibratory shock.	....	....	Ditto; Ferrara, *loc. cit.*
—— April 1.	Castel-Buono in Sicily...	Another shock	....	....	Ferrara, *loc. cit.*
—— —— 3. 10 P.M.	Calcutta	Shocks from N. to S., and *vice versâ*, up to 11^{h}.	....	....	Garnier, Météorologie, p. 137.
—— —— 22. 5^{h} 3^{m} A.M.	Island of Penang, Straits of Malacca.	Two shocks............	....	....	Ditto.
—— —— 28. 5^{h} 45^{m} A.M.	Island of Martinique ...	A single shock.........	....	....	Ann. de Chim. et de Phys. t. xxiv. p. 429; Archiv. des Découv. 1824, p. 211.
—— May 6.	Lunröe in Norway	Another shock.........	....	....	Keilhau.

1.	2.	3.	4.	5.	6.
1823. May 7. 5h 30m P.M.	Bucharest in Wallachia.	A vertical shock			Ann. de Chim. et de Phys. t. xxxiii. p. 406.
—— —— 9.	Ditto	Another shock			Ditto.
—— —— 19.	Aleppo	Very violent shocks. The motion had continued more or less since January.			Journ. des Débats, 16 Juillet; Moniteur, 17 Juillet.
—— —— 26.	Ditto	More shocks			Ditto.
—— —— 28.	Castel-Buono in Sicily	Another severe shock.			Ferrara, *loc. cit.*
—— —— 30. Soon after sunset.	Some places on the Canadian shore of Lake Erie.	An earthquake *said* to have been felt after the sudden agitation of the lake on this day.	The waters of Lake Erie rose suddenly to the height of 9 feet on the Canadian shore, carrying men and boats inland with irresistible force. The water then fell, and rose again twice to the height of 7 feet. In twenty minutes it resumed its original level, and all was still again. The phænomenon was most remarkable at the mouths of the rivers Otter and Kettle. The water of the former was driven back a mile and a half.		Férussac, Bull. des Sc. Géol. t. xiii. Mai 1828, p. 130; Hertha, B. iii. 1825; Zeitung, S. 81; Trans. Lit. and Phil. Soc. New York, vol. ii. p. 1. § 25.
—— —— 31.	Borgo - San - Sepolcro, near the Tiber.	A slight shock			Ann. de Chim. et de Phys. t. xxxiii. p. 406.
—— —— ...	On board the ship 'Nearchus,' on her voyage from S. America to Calcutta. Her place at the time not given.	A severe vibratory shock, lasting nearly four minutes.			Monthly Magazine, vol. lviii. p. 530.

1823. June 12.	Palermo	Another shock			Poggendorff's Annalen, B. xxiv. S. 54.
——— 19.	Souli in Turkey			The remainder of the fortifications destroyed by an earthquake.	Constitutionnel, 29 Juillet.
——— 30.	About Antioch in Syria.	Shocks were of almost daily occurrence here at this time, but at Aleppo they had become less frequent.		It had rained during the last week of May and the whole month of June. Rain is said to be rare in Syria from March to October.	Journ. des Débats, 1 Oct.; Moniteur, 5 Sept. et 3 Oct.; Ann. de Chim. et de Phys. t. xxxiii. p. 406.
——— ...	In Chili	Two shocks during the month.			Ann. de Chim. et de Phys. t. xlii. p. 407.
—— July 1 to 26.	In Iceland	Earthquake shocks		Accompanying three eruptions of the volcanos Koettegiaa and Orfieldsjökul during this time. There had been no eruption for 68 years before.	Philos. Magazine, 1823, Sept. p. 233; Monthly Magazine, Nov. p. 312; Ann. de Chim. et de Phys. t. xxiv. p. 432; Constitutionnel, 11 Sept.; Journ. des Débats, 11 Sept. et 9 Oct.
——— 7. 11h 30m P.M.	On board the ship 'Layton,' in 35° 19′ S. lat. (long. not given), near the island of Tristan d'Acunha. Also felt on board the Dutch ship 'Phelentait,' in 36° 51′ S. lat.	A vibratory shock which wakened the crew.		The Ann. de Chim. et de Phys. gives the date 27th July.	Monthly Magazine, vol. lviii. Jan. 1825, p. 530; Ann. de Chim. et de Phys. t. xxx. p. 411.
——— 8. After 1h 30m A.M.	On board the same ship 'Layton.' Not felt by the Dutch vessel.	A stronger vibration than the last, of about 2 secs. duration. (The former shock lasted longer).			Ditto.
——— 13, and some other days of this month.	On the coasts of Valdemone, Sicily, at Messina, and on the south coast at some places in the Val-di-Noto.	Several shocks			Ferrara, *loc. cit.*
——— 18.	Sienna in Tuscany	A slight shock			Ann. de Chim. et de Phys. t. xxxiii. p. 406.
—— Aug. 7.	Ragusa, and as far as 15 miles round it to seaward, and still further on the land	An earthquake		The island of Meleda remained almost at rest during this earthquake, though it was slightly perceived there.	Stulli sulla detonazioni dell' isola di Meleda, Biblioteca Italiana, vol. xxxiii. p. 347.

1.	2.	3.	4.	5.	6.
	side. Scarcely felt in the neighbouring islands.				
1823. Aug. 10.	Palermo. More slightly felt at different places in the Valdimazzaro.	Two shocks, of moderate intensity, apparently in a westerly direction.			Ferrara, *loc. cit.*
—— —— 20.	Ragusa and in Turkish Bosnia.	A severe shock	The sea retired nearly a mile from the coast.	Preceded by great heat, which occasioned contagious diseases. A meteor appeared immediately before the shock. In Bosnia much damage was done. Garnier records these facts in October.	Tilloch's Magazine, vol. lxii. p. 315; Ann. de Chim. et de Phys. t. xxxiii. p. 407.
—— —— 22.	Pawlowsk in the government of Woronesch, Russia.	Slight shocks			Ditto.
—— —— 23. 5h 30m P.M.	Island of Meleda in the Adriatic.	A strong shock		A mass of rock was moved from its place and rolled away. The detonations heard in this island in 1822 began again in this year, and were heard at different times from March to November (May and June excepted), and afterwards in the month of February 1825. They were occasionally accompanied by slight motion of the ground, but the present is the only distinct shock mentioned.	Paul Partech, Bericht über das Detonations, Phänomen auf der Insel Meleda, u. s. w. Wien, 1826.
—— —— —	Pawlowsk in the government of Woronesch, Russia.	Slight shocks			Tilloch's Magazine, vol. lxii. p. 315; Ann. de Chim. et de Phys. t. xxxiii. p. 407.
—— —— 24.	Ditto	Ditto		In Tilloch's Magazine the third day given for these shocks is the 27th.	Ditto.
—— —— 25. 2h and 2h 30m A.M.	Aix in Savoy	Two shocks, of which the second was more violent than the first.			Constitutionnel, 5 Sept.
—— —— ...	Scala-Nova in Anatolia.	Rather violent shocks.		Houses were thrown down	Moniteur, 28 Oct.
—— Sept. 2. Between 7 and 8 P.M.	Valencia in Spain	A very severe shock		Accompanied by a rolling noise like that of a cannon.	M. Perrey's Memoir on Earthquakes in Spain and Portugal, p. 29.
—— —— 9. 1h 30m P.M.	Near Possnitz 2 miles S. of Leobschütz, Silesia.	The noise lasted five to seven seconds.		A loud noise, at first like that of waggons, but afterwards increasing till like thunder, was	Kastner's Archiv für Naturkunde. B. v. S. 479.

				heard; and, although the air was perfectly calm, trees, grass, &c. were found to have been tossed about as if by a whirlwind. As v. Hoff remarks, it is very doubtful whether this belongs to the class of earthquake phænomena.	
1823. Sept. 12. About midnight.	At the convent of St. Bernard.	A rather severe shock		Accompanied by loud noise	Ann. de Chim. et de Phys. t. xxiv. p. 429; Archiv. des Découv. 1824, p. 211.
—— Oct. 3. 1 A.M.	Island of Martinique	Two strong shocks			Ann. de Chim. et de Phys. t. xxv. p. 432.
—— —— 8.	Lunröe in Norway	Two shocks			Keilhau.
—— —— 9.	Ditto	Three more shocks			Ditto.
—— —— 11.	Ditto	One more shock			Ditto.
—— —— 23.	Minschrift in Siberia	Slight shocks		Accompanied by extraordinary heat	Ann. de Chim. et de Phys. t. xxxiii. p. 407.
—— —— ...	Fiorizano (or Fiorenzuola in the duchy of Parma?).	A slight shock			Ditto.
—— Nov. 11. 5h 45m A.M.	Martinique and other West Indian islands.	Two severe shocks, of remarkably long duration.		No remarkable damage done	Ditto, t. xxiii. p. 378; Férussac, Bull. des Sc. Nat. 1824, t. ii. p. 236.
—— —— 16.	Christiania in Norway				Keilhau.
—— —— 17.	Ditto				Ditto.
—— —— 19. 10h 45m P.M.	Santiago in Chili	A shock			Ann. de Chim. et de Phys. t. xlii. p. 407; Annual Register.
—— —— 21. 5h 30m P.M.	Freiburg in the Brisgau. Also felt at Breisach, Strasburg, Kenzingen, and Schlettstadt.	A vibratory shock from W. to E., lasting several seconds.		At Breisach a loud noise was heard. At some other places there was only a low noise like a heavy gust of wind. The sound was heard at one or two places where the shock was not perceptible. The Ann. de Chim. et de Phys. make the hour 9h 30m.	Allgemeine Zeitung, 1823, Nr. 334; Arch. des Découv. 1824, p. 211; Ann. de Chim. et de Phys. t. xxiv. p. 429.
—— —— 23. 10h 30m P.M.	Arezzo and Sabbiano in Italy.	A slight shock		Accompanied at Sabbiano by a noise like that of a gust of wind.	Ann. de Chim. et de Phys. t. xxxiii. p. 406.
—— —— 24. 6h 5m P.M.	At Stockholm and some places in Dalecarlia, Sweden. On the same day a shock was felt at Christiania, Friedrichstahl, Mors, and Westerhæs.	A slight shock, felt some minutes earlier in places situated to the west.		Accompanied by a dull sound which seemed to come down from the atmosphere. Shortly after, there was a violent tempest. The shock was not at all felt at the bottom of the mines, but those who were on the ladders of the same were so shaken that they feared the ladders were about to fall.	Berzelius' Jahresbericht, Nr. 4. S. 268; Journ. des Débats, 25 Déc.; Moniteur, 26 et 27 Déc. et 4 Janv.; Keilhau.

1.	2.	3.	4.	5.	6.
1823. Nov. 26. $11^h 50^m$ (A.M. or P.M.?).	Calcutta	A shock		Accompanied by subterranean noise.	Garnier, Météorologie, p. 139.
—— —— 30. $3^h 10^m$ P.M.	Island of Martinique	A strong undulation.	The sea rose after the shock, and occasioned some damage in the harbours.	Preceded by a very intense noise. The heat had been suffocating during the day. Abundant rain followed the earthquake and lasted ten days.	Ann. de Chim. et de Phys. t. xxx. p. 411.
—— Dec. Beginning of the month.	In the government of Taurida, Russia.	Rather severe shocks.			Ditto, t. xxxiii. p. 407.
—— —— 4. 1 A.M.	Rome	A little shock			Ditto; Journ. des Débats, 23 Déc.; Moniteur, 24 Déc.
—— —— 7.	Bâle	A vibratory shock			Merian, p. 5.
—— —— 13. 1 A.M.	Island of Martinique	Two shocks, slighter than those of November 11.			Ann. de Chim. et de Phys. t. xxxiii. p. 407.
—— —— — (or 16). 3 A.M.	Belley in the departm. Ain, France.	Rather severe shocks, which lasted some seconds, and appeared to be from E. to W. Some persons at Belley asserted that they felt a former shock at 1 A.M.		Preceded by an explosion like that of large pieces of ordnance. An inhabitant of Biaonces, who was on the top of a hill at the time of the shock, reported that the heavens appeared to him all on fire an instant after the explosion, although he saw no meteor.	Constitutionnel, 21 Déc.; Ann. de Chim. et de Phys. t. xxiv. p. 429.
—— —— ...	Mühlheim in the Russian province of Cleve-Berg.	One shock			Heidelberg Jahrbücher, 1825, Mai, S. 470.
1824. Jan. 2. 7 P.M.	Macao in China	Vibratory shock, lasting five seconds.			Asiatic Journal, 1824, Nov. p. 488.
—— —— 5. Between 3 and 4 A.M.	Trinidad in the island of Cuba.	A rather severe shock.			Ann. de Chim. et de Phys. t. xxvii. p. 377; Archiv. des Découv. 1824, p. 212.
—— —— 6. $5^h 30^m$ A.M.	Bergen in Norway	Severe shocks from S.W. to N.E.		Accompanied by subterranean noise which lasted more than a minute.	Ditto; Moniteur, 20 Fév.
—— —— Night between 6 & 7.	Hartenberg in the circle of Elbogen, Bohemia.	The first shocks of a great number felt in this district in January and February.		On the 1st of Jan. a noise like thunder had been heard, during great cold and a perfect calm.	Allgemeine Zeitung, 1824, Nr. 23. S. 91; Preuss. Staatszeitung, 1824, Nr. 47. S. 211; Kastner's Archiv, B. i. S. 320.

1824. Jan. 7. In the morning.	Hartenberg in the circle of Elbogen, Bohemia.	Another shock		The plaster was detached from the ceiling of a chamber in the castle.	Ditto.
—— 9. $2^{h}\ 30^{m}$ A.M.	In the lower parts of the district of Weinsiedel in the Fichtelgebirge, near the Bohemian frontiers.	Ditto		In some places accompanied by subterranean rolling noise.	Ditto.
—— —— $8^{h}\ 15^{m}$ P.M.	Hartenberg, Gossengrün, Silbergrün, Bleistadt, Annadorf, Schossenrent, Pirkles, Marklesgrün, Buterbach, Heinrichsgrün, and very violently in the mines of Primles.	Ditto			Ditto.
—— —— 11 P.M.	Ditto	Ditto			Ditto.
—— —— 10. $2^{h}\ 45^{m}$ A.M.	Ditto	Ditto			Ditto.
—— —— 3 A.M.	Ditto	Ditto			Ditto.
—— —— 5 A.M.	Ditto	Ditto			Ditto.
—— —— $7^{h}\ 30^{m}$ P.M.	Hartenberg	Ditto	At 4 P.M. the ice on the Zwoda near Hartenberg broke up, although the temperature was only −7° Reaum.		Ditto.
—— —— 9 P.M.	Ditto	Ditto			Ditto.
—— —— 11 P.M.	Ditto	Ditto			Ditto.
—— —— $11^{h}\ 15^{m}$ P.M.	Several other places in the Fichtelgebirge.	Ditto			Ditto.
—— —— 11. $10^{h}\ 45^{m}$ A.M.	Ditto	Ditto			Ditto.
—— ——	Hartenberg	Ditto			Ditto.
—— —— Night between 11 & 12.	Ditto	Ditto, rather more severe.		Accompanied by subterranean noise	Ditto.

1.	2.	3.	4.	5.	6.
1824. Jan. 13. Noon.	Several places in the Fichtelgebirge.	Another shock			Authorities quoted above (on the 6th).
—— 1 P.M.	Ditto, and very strongly in the Bohemian Erzgebirge, especially in Fribus and Bleistadt, and *most* violently in Prinkles, Pernau, and Leopoldhammer.	Ditto		Wells in the Erzgebirge which had been dry for years became suddenly full of water. This was remarked too at Adorf.	Ditto.
—— 14.	Hartenberg in same region.	Slight tremblings, which recurred on several following days.		Accompanied by subterranean noise.	Ditto.
—— 15. $0^h 20^m$ A.M., $0^h 30^m$, and 2 A.M.	Boves in the province of Coni, Piedmont.	Three shocks, at the hours mentioned.		A meteoric stone fell on this day at Arenazzo near Ferrara (Chladin).	Mém. de l'Acad. de Turin, t. xxix. p. 1.
—— $3^h 30^m$ A.M.	In the district of Münchberg in the Fichtelgebirge.	Another shock			Allgemeine Zeitung, &c., as above.
—— 6 P.M.	In Chili (at Santiago ?).	A severe shock			Ann. de Chim. et de Phys. t. xlii. p. 407.
—— 18. 8 A.M.	Hartenberg again	Two violent shocks		Preceded by subterranean noise like thunder	Allgemeine Zeitung, &c., as above.
—— $7^h 45^m$ P.M.	Ditto	Another shock		Accompanied by a strong west wind, a fall of snow, and a slight sinking of the mercury in the barometer.	Ditto.
—— 10 P.M.	Ditto	Ditto		Ditto	Ditto.
—— $11^h 45^m$ P.M.	Ditto	Ditto		Ditto	Ditto.
—— 19. 5 A.M.	Ditto	A severe shock			Ditto.
—— 9 A.M.	Ditto	Ditto			Ditto.
—— $9^h 30^m$ A.M.	Ditto	Ditto			Ditto.
—— $11^h 30^m$ A.M.	Ditto	Ditto			Ditto.

1824, Jan. 19. 11^h 35^m A.M.	Hartenberg again	A severe shock			Ditto.
— — — 3 P.M.	Graslitz in same region.	Ditto			Ditto.
— — — 4 P.M.	Ditto, and at Eger, and Heinrichsgrün.	Ditto. Very severe at Heinrichsgrün.			Ditto.
— — — 4^h 30^m P.M.	Hartenberg again. (These shocks were felt, though slightly, at Falkenau and Ellenbogen; and more strongly at Stobzenhayn, Hobzbach, the Bohemian Wiesenthal, &c.)	The two most severe shocks felt at this place. The motion seemed to go from Graslitz to Eger, and thence to Hartenberg.		On the 23rd of January a rapid fall of the barometer took place in Germany, France, all Italy, &c. In the after part of the day the mercury stood unusually low, and on the 24th it rose as rapidly as it had fallen. Kastner's Archiv, B. i. S. 125. B. ii. S. 394.	Ditto.
— — 28.	Lunröe in Norway	One shock			Keilhau.
— — 29.	Ditto	Ditto			Ditto.
— — 30.	Ditto	Ditto			Ditto.
— — ...	Manilla in the island of Luçon, Philippine Isles.	Terrible shocks		After the shocks numbers of dead fish were seen floating on the surface of the river.	Garnier, Météorologie, p. 140.
— Feb. 2. 9 A.M.	Again in the region of the Erzgebirge and Fichtelgebirge, especially at Heinrichsgrün.	The shocks began again.			Preuss, Staatszeitung, &c., as above.
— — — 11 P.M.	Ditto	Another shock		The subterranean noise lasted an hour	Ditto.
— — 3. 2 A.M.	Ditto	Ditto, slight			Ditto.
— — — 6 A.M.	Ditto	Ditto, slight			Ditto.
— — — 10^h 45^m A.M.	Ditto	Ditto, severe			Ditto.
— — 4. 7 A.M.	Ditto	Two strong shocks			Ditto.
— — — At Bobbio, 11^h 50^m P.M. At Voghese, 10^h(11?) 56^m.	Bobbio in Italy (kingdom of Sardinia). Also felt at Ivree and Voghese.	At Bobbio two severe shocks. Three were felt at Ivree, and but one at Voghese. The latter was strong and lasted four minutes.		Accompanied at Bobbio by noise like that of a storm.	Moniteur, 18 et 20 Fév.; Ann. de Chim. et de Phys. t. xxxiii. p. 406.

1.	2.	3.	4.	5.	6.
1824. Feb. 5. 5h 30m A.M.	Again in the Fichtelgebirge and Erzgeberg. Hartenberg was apparently the centre of all these shocks.	The general direction of all these shocks seemed to common observation to be N.E. to S.W. The shocks were more severe in the northern than the southern part of the district shaken.	....	The places at which these shocks of Jan. 6–19 and Feb. 2–5 were felt lie nearly together in a line from N.E. to S.W., on the southern slope of the Erzgebirge. On the south bank of the Eger no motion was observed. At Adorf and Münchberg, however, which lie out of the line mentioned, some motion was felt.	Preuss, Staatszeitung, &c., as above.
—— —— 7.	Lunröe in Norway	Another shock	....	....	Keilhau.
—— —— 11.	Irkutsk in Siberia	A slight shock	....	....	Poggendorff's Annalen, B. ii. S. 155; Ann. de Chim. et de Phys. t. xxvii. p. 377.
—— —— 12. Between 8 and 9 P.M.	Eglisau in the Canton of Zurich.	A violent shock	....	....	Ann. de Chim. et de Phys. t. xxxiii. p. 407.
—— —— 18. A little after midnight of the 17th.	Sala in the province of Palermo (Parma?).	A strong vertical shock	....	....	Ditto.
—— —— — 5h 30m P.M.	Ditto	A very strong shock, at first vertical, afterwards horizontal, lasting six seconds.	....	....	Ditto.
—— —— 21. 8 P.M.	Island of Sta Maura (Ionian Isles).	A violent shock	....	Many houses were injured	Ditto, t. xxvii. p. 377; Arch. des Découv. 1824, p. 212.
—— Mar. 3. (Ash Wednesday) 9 A.M.	Chessy in the departm. Rhone, France.	A strong shock *said* to have been felt.	....	Bells rang. On the 2nd and 3rd the barometer was very low in Germany, France, and Italy. There was a storm in the Mediterranean, especially on the coasts of Italy, and a heavy fall of snow at Rome, Naples, &c. Kastner's Archiv, B. i. S. 382; B. ii. S. 401.	Perrey's Memoir on Earthquakes in the basin of the Rhone. Notes Additionnelles, p. 15.
—— —— 4.	Pieve-Santo-Stefano in Tuscany.	A strong undulatory shock from W. to E.	....	....	Ann. de Chim. et de Phys. t. xxxiii. p. 406.
—— —— 8. About 2 A.M.	Irkutsk in Siberia	Three severe shocks...	....	....	Ditto; Journ. des Débats, 7 et 8 Juin.
—— —— 11. At noon.	In the mine of Riddersk and at Zyrianof, at the	One shock	....	....	Férussac, Bull. des Sc. Nat. t. vii. Juillet, 1826, p. 330.

	foot of the Kholzoun range in the S.W. of the Altai Mountains.				
1824. Mar. 12.	Lunröe in Norway	Another shock			Keilhau.
—— —— 16.	Borgo-San-Sepolcro in Italy.	A strong horizontal shock.			Ann. de Chim. et de Phys. t. xxxiii. p. 407.
—— —— 27.	Lunröe in Norway	Another shock			Keilhau.
—— April 1. 3 (A.M. or P.M.?).	In the mine of Zmeinogorsk and at Zyrianof in the Altai Mountains.	One shock			Férussac, Bull. des Sc. Nat. t. xi. p. 420.
—— —— 10. A few minutes before 10 P.M.	Kingston and other places in Jamaica. At Spanishtown and Old Harbour the shocks were very strong.	Very severe shocks. The motion lasted about 30 seconds, and was the most violent felt for many years. Followed by other slighter shocks from the 10th to the 15th. At Yallahs there were shocks during the night of the 13th and between 1 and 2 A.M. on the 14th. At Port Royal on the 12th about 9^h 48^m P.M., and on the 13th at about the same hour.		Preceded by a violent wind, and accompanied by loud subterranean noise. Three or four houses fell.	Ann de Chim. et de Phys. t. xxvii. p. 377; Verneur, Journal des Voyages, t. xxiii. p. 101.
—— —— 20. About 3 A.M.	Island of St. Thomas, West Indies.	A terrible earthquake		Accompanied by a noise like thunder. Many people were thrown out of their beds. A building was swallowed up in consequence of this commotion.	Ann. de Chim. et de Phys. t. xxvii. p. 377.
—— May 4.	Lunröe in Norway	Another shock			Keilhau.
—— —— 31. 4 P.M.	Burg in Prussia	A slight shock			Ann. de Chim. et de Phys. t. xxvii. p. 377.
—— June 2.	Schiraz in Persia	Some slight motion premonitory of the great earthquake of the 25th.			v. Hoff.

1.	2.	3.	4.	5.	6.
1824. June 6.	Port-au-Prince in St. Domingo.	One shock			Moniteur, 25 Janv. 1826.
—— —— 10.	Sienna in Italy	A strong shock			Ann. de Chim. et de Phys. t. xxxiii. p. 406.
—— —— 19.	St. Helena			A large mass of rock fell from the side of Loddes Hill. Perhaps not an earthquake shock.	Constitutionnel, 27 Août.
—— —— 23 or 25. 5h 30m A.M.	In Persia, particularly at Schiraz.	A violent shock, followed by many slighter ones for six days and nights. The principal damage was done by the first and three others which followed it before 10 A.M.		A part of the city of Schiraz was almost completely destroyed and swallowed up. Next to this city Kazroun suffered most. In the neighbourhood of the latter place some mountains were levelled. The day of the most violent shocks was, according to the Persian calendar, the 27th of the month Chaval, in the year 1239. The month of April has been erroneously given as the date of this event. (On the same day there was a renewal of the eruption of Gunong Api in the island of Banda, which began on June 9.)	Verneur, Journal des Voyages, t. xxv. p. 118 (from the Bombay Courier); Revue Encycl. 1825, Mars, p. 846; Hertha, B. i. 1825, &c.
—— July 9.	New Brunswick, North America.	A severe shock		Accompanied by an explosion like that of a piece of ordnance.	Ann. de Chim. et de Phys. t. xxvii. p. 377; Arch. des Découv. 1824, p. 213.
—— —— 15.	Monte-Rotundo in the States of the Church.	Ditto		On the 19th (or 29th?) of July there was an extraordinary commotion in the lake of Massaciuccoli, territory of Lucca, attended with a sulphurous smell. Numbers of small fish died.	Ann. de Chim. et de Phys. t. xxxiii. p. 407, t. xxvii. p. 386; Kastner's Archiv, B. iv. S. 383.
—— —— 18. 10h 20 or 25m P.M.	In the departm. Eastern Pyrenees, Aude, Tarn, &c.	At Roussillon the shock appeared to be from N.E. to S.W., and lasted four or five seconds.		At Collioure a subterranean noise preceded the shock, and continued four or five seconds after it. At Mont-Louis the atmosphere had been clear and calm all day, but immediately after the shock a violent storm arose. At Perpignan the thermometer rose in the evening to 35° C., and the air seemed to be filled with burning vapours. At Carcassone there was a blast of wind so impetuous that the inhabitants compared it to the explosion of a gun. All points of the horizon had been illuminated during the day by lightning unaccompanied by thunder. **There was a heavy fall of large hail, with thunder and lightning, at Gotha between 1 and 2 P.M.**	Le Constitutionnel, 28 Juillet; Ann. de Chim. et de Phys. t. xxvii. pp. 210 et 377; Arch. des Découv. 1824, p. 213.

1824. July 19. 5 A.M.	Lisbon	A slight shock		The thermometer rose on this day to 40°·5 C. in the shade.	Moniteur, 11 Août; Constitutionnel, 10 Août; Ann. de Chim. et de Phys. t. xxvii. p. 377.
——— 29 to 31.	Lanzerote, Canary Isles	Terrible shocks, which became constantly more violent during the time mentioned.		Accompanied by subterranean noise. On the 31st the earth opened and a volcanic eruption began, which lasted until next day. Three other craters afterwards opened, and large masses of lava, vapour, and salt water were ejected. The account is not clearly given, and the 29th of August is wrongly recorded as the date of the commencement, by the Moniteur. The eruption continued until October or even November.	Moniteur, 24 Janv. 1825; Férussac, Bull. des Sc. Nat. t. v. p. 45; t. x. p. 45; Ann. de Chim. et de Phys. t. xxvii. p. 382; Constitutionnel, 23 Oct.; v. Buch, Beschriebung der Canarischen Inseln.
—— Aug. 1 and 2.	Granada in Spain	Eight shocks during these two days.			Ann. de Chim. et de Phys. t. xxvii. p. 377.
——— 8. In the morning.	Comrie in Perthshire	A strong shock		Accompanied by noise as of a heavy carriage rolling upon pavement.	Ditto.
——— 10.	Perth	A shock		Accompanied by very loud noise	Ditto, t. xxxiii. p. 408.
——— 13. Early in the morning.	San-Pietro-in-Bagno, and Salvapiana in Tuscany.	Twenty shocks, of which but three were sufficiently strong to cause the church bells to sound. During the following day and night the shocks recurred, but without producing any notable effect.		Before these shocks a mist of a peculiar character had been observed in the atmosphere, especially round the sun. A traveller had remarked a fire-ball the night before.	Ditto, t. xxvii. p. 377; Preuss. Staatszeitung, 1824, Nr. 217. S. 954.
——— 18.	Harderwyk in Holland	A shock directed towards the S.W.		Accompanied by loud noise like that of a carriage rolling rapidly over an uneven pavement.	Ann. de Chim. et de Phys. t. xxvii. p. 377; Constitutionnel, 7 Sept.; Revue Encycl. Oct. p. 244.
——— 21.	Lunroe in Norway	A severe shock			Keilhau.
——— 29. 2 and 9 A.M.	In Chili. (At Santiago?)	Severe shocks			Ann. de Chim. et de Phys. t. xlii. p. 407.
—— Sept. 2. 5 A.M.	In the mine Klintchkinsk, 167 wersts from Nertschinsk in Siberia.	A shock		Preceded by an extraordinary noise, passing from N. to S., which lasted four minutes. All the buildings rocked. This is said to have been the first shock felt since January 1800.	Férussac, Bull. des Sc. Nat. t. viii. Mai, 1826, p. 21, quoting Sibirsky Vestnick, 1824, Nrs. 15 and 16, p. 97.
——— 5.	Lunröe in Norway	Another shock			Keilhau.

1.	2.	3.	4.	5.	6.
1824. Sept. Night between 7 and 8.	Island of Guadeloupe ...	Several shocks.........	....	A terrible storm during the night, with thunder and lightning, and on the following morning, heavy rain. Between 1 and 2 A.M., when the storm was at its height, the barometer fell 7 lines below its ordinary height; there an unheard of occurrence.	Journal de Frankfort, 1824, Nr. 325; Ann. de Chim. et de Phys. t. xxxiii. p. 408; Constitutionnel, 3 Sept.
—— —— 9. 10 P.M.	Basseterre in the same island.	Some more shocks ...	On the 13th a remarkable and irregular rise and fall of tide at Plymouth.	....	Constitutionnel, 16 Nov.; Archiv. des Découv. 1824, p. 215.
—— Oct. 3. 1 A.M.	Martinique in the West Indies.	Two shocks..........	....	People were awakened by the shocks, but no damage was done.	Ann. of Phil. 1824, Sept. p. 204; Ann. de Chim. et de Phys. t. xxxiii. p. 408.
—— —— 26.	Manilla in the island of Luzon, Philippine Isles.	Slight shocks had been felt here in the former part of the month, but that of this day was the most violent which had been felt since 1795 (or 6?).	....	Some churches, one of the bridges, and many private houses fell. The barracks were completely ruined, so that a camp had to be formed, which was itself destroyed by a tempest on the 1st of November. About four miles from the city the ground opened, and dead fish were observed immediately after floating on a river near.	Singapore Chronicle, 25th November 1824.
—— —— Night between 27 and 28.	Island of Meleda in the Adriatic.	A shock which made the windows rattle.	....	Detonations were heard in this island on the 14th, 25th, 28th, and 29th of October, and 1st, 2nd, 11th, 12th, and 15th of November, unaccompanied by any shock.	Paul Partsch, Bericht, u.s.w.
—— —— 28.	Dubossar in the Crimea	Rather severe shocks	....	On the 1st of November a violent tempest blew over the Crimea.	Journal de Frankfort, 1825, Nr. 9.
—— —— 29. 8h and some min. P.M.	Chambéry in Savoy, and the neighbourhood.	A slight shock.........	....	....	Ann. de Chim. et de Phys. t. xxvii. p. 377, t. xxxiii. p. 408; Constitutionnel, 20 Nov.
—— —— —— During the night.	Mühlheim, Stornberg, and Schramberg, in the Brisgau.	Shocks from S. to N.	....	At Brunswick some persons supposed they felt a shock during a storm on this night.	Ditto; Allgemeine Zeitung, 1824, Beil 241.
—— —— 30.	In the West Indies. (At Martinique?)	More shocks	....	....	Ann. de Chim. et de Phys. t. xxxiii. p. 408.
—— Nov. Night between 13 and 14.	Mayence	A vibratory shock ...	....	A fire-ball was also observed	Allgemeine Zeitung, 1824, Beil 225. S. 903.

1824. Nov. 15. 5h 30m A.M.	Odensee in Denmark	Some persons *supposed* they felt a shock.		During a violent storm. For a detailed account of the storms and inundations of the latter part of this year, vid. v. Hoff, Th. v. S. 216.	Preuss, Staatszeitung, 1824, Nr. 282, p. 1219.
—— —— 30. 3h 30m P.M.	Island of Martinique, West Indies.	A severe shock	At St. Pierre a very high tide threw many ships upon the strand.	Accompanied by subterranean noise, which appeared at first, however, to proceed from the atmosphere. The earthquake was preceded by great heat, which ceased after the shock, and heavy rain began, which lasted for ten days.	Revue Encycl. 1825, Fév. p. 542; Férussac, Bull. des Sc. Math. t. iii. p. 363, t. vi. p. 17; Ann. de Chim. et de Phys. t. xxxiii. p. 408.
—— —— During the last few days.	Catanzaro and Cosenza in Calabria.	Several shocks		Caused no damage. At the first named place extremely hot weather followed the shock, at the second heavy rain.	Journal de Frankfort, 1824, Nr. 359.
—— Dec. 6. 2h 45m P.M.	Portsmouth, Havant, Bognor, Aldwick, Emsworth, and Chichester on the south coast of England.	A trembling of three to five seconds' duration, during which the ground seemed to heave a little.		Windows rattled, and objects which were freely suspended swung about. In the morning the sky was full of electrical clouds. After the shock a S.W. wind arose. No similar phænomenon had been felt in this part of the country since 1812, the date of the great earthquake of Caraccas.	Philos. Magazine, 1825, Jan. p. 70; Férussac, Bull. des Sc. Nat. t. vi. p. 186; Journ. des Débats, 12 Déc.
—— —— 8.	Lunröe in Norway	Three shocks			Keilhau.
—— —— —	Palermo	A shock			Poggendorff's Annalen, B. xxiv. S. 54.
—— —— 10.	Corigliano and Longobucco, not far from Rosano, in Calabria Citeriore.	Several shocks		Houses were thrown down. Three persons perished.	Journ. de Frankfort, 1824, Nr. 364; Preuss, Staatszeitung, 1825, Nr. 3. S. 20; Constitutionnel, 30 Déc.
—— —— 17. 6h 23m P.M.	Fourteen or fifteen leagues to the north of Mariquita in the republic of Venezuela, South America.	Very severe shock		Not felt at Mariquita	Ann. de Chim. et de Phys. t. xlii. p. 411; Férussac, Bull. des Sc. Nat. Janv. 1831, p. 16.
—— —— — 11 P.M.	Ditto, at Mariquita itself.	The most violent earthquake felt here during this year.		Bells were made to sound. M. Roullin says that two or three years pass without any earthquake being felt in the territory of Venezuela, that then, after a dry and hot summer, the shocks recommence, increase in intensity and frequency until ten or twelve occur in the same day, and on the fall of the first winter rains, suddenly cease. Great irregularity prevails in the propagation of these shocks, and often no correspondence can be traced in them at places very near each other. The barometer is not influenced by them.	Ditto.

1.	2.	3.	4.	5.	6.
1824. Dec. 23. Between 5 and 6 A.M.	Hamburg. Also at Alfter, a village two miles and a half from Bonn on the Rhine.	Shocks *supposed* to have been felt. At Alfter there were two.		During a violent storm at Hamburg. At Alfter the beds are said to have swung from side to side.	Journal de Frankfort, 1825, Nr. 2; Gothaische Zeitung, 1825, Nr. 4; Journ. des Débats, 6 Janv. 1825.
—— —— 30.	Schiraz in Persia	Several shocks			Journal de Frankfort, 1825, Nr. 50.
1825. Jan. 5. 9 P.M.	Preuschdorf in the Canton of Worth, arrondissement of Weissenburg, Alsâce. Also felt at Lampertsloch.	A slight tremulous shock, lasting 40 or 45 seconds.	On the 3rd the sea rose and fell in an unusual way at Copenhagen.		Constitutionnel, 20 Janv.; Ann. de Chim. et de Phys. t. xxx. p. 412.
—— —— —	Cosenza, Rossano, and Corigliano, in Calabria Ultra.	A slight shock, most strongly felt at the last two places.			Journal de Frankfort, 1825, Nr. 41.
—— —— 13. $1^h\ 30^m$ A.M.	Saint-Pierre in the island of Martinique.	Two shocks		The temperature had been very high up to the moment of the shocks.	Cuvier, Hist. des Sc. Nat. t. ii. p. 247.
—— —— 17. $6^h\ 45^m$ A.M.	Florence	A slight shock			Ann. de Chim. et de Phys. t. xxx. p. 412, t. xxxiii. p. 408; Constitutionnel, 9 Mars; Journ. des Débats, 10 Mars.
—— —— 18. 6 A.M.	Teramo in the Abruzzo, Italy.	Two ditto			Ditto.
—— —— —	Lunröe in Norway	Another shock			Keilhau.
—— —— 19. Between 11 A.M. and noon. At Prevesa, at $11^h\ 45^m$.	Island of Sta Maura, Ionian Isles.	A violent earthquake.		Almost totally destroyed the town of Sta Maura. Many of the inhabitants perished. At Prevesa also houses were thrown down, and the earth opened. Heavy rain followed the earthquake, and lasted several days.	Ann. de Chim. et de Phys. t. xxx. p. 412, t. xxxiii. p. 408; Férussac, Bull. des Sc, Nat. t. v. p. 48, t. xi. p. 199; Constitutionnel, 9 Mars; Journ. des Débats, 10 Mars; Preuss, Staatszeitung, 1825, Nrs. 63 u. 82.
—— —— 20. 2 and 4 A.M.	Ditto	More shocks		Two small houses were thrown down	Ditto.
—— —— —	Iceland, in the southern quarter of the island.	Severe shocks. Several others were felt in the northern part of the island during the month.		Some time before, violent storms and disastrous inundations had been experienced.	Journal de Frankfort, 1825, Nr. 126; Ann. de Chim. et de Phys. t. xxx. p. 412.
—— —— 21. $2^h\ 45^m$ P.M.	Marseilles	Two slight shocks, with an interval of 5 or 6 seconds.		v. Hoff gives $11^h\ 45^m$ P.M. as the hour of these shocks.	Ann. de Chim. et de Phys. t. xxx. p. 413; Leonhard's Zeitschrift, 1826, B. ii. S. 283.

1825. Jan. 22. 1 P.M.	Ditto, and at Aix in Provence.	A slight shock			Ann. de Chim. et de Phys. t. xxx. p. 413; Leonhard's Zeitschrift, 1826, B. ii. S. 283; Constitutionnel, 30 Janv.
—— —— 28. Midnight.	In the mines of Zyrianof, district of Koliwano, Wosskressensk, between the Irtisch and Buktarma, at the foot of the Khobzoun range, Altai Mountains.	A shock from E. to W.; strongly felt on the surface of the ground.		Accompanied by loud subterranean noise	Férussac, Bull. des Sc. Nat. t. viii. p. 329, t. xi. p. 420, quoting Asiatsky Vestnik, 1825, Mars, p. 285.
—— —— 30.	Stanza - Protsch - Nookopsin on the right shore of Lake Kouban, Russia.	A shock		Accompanied by rather loud rolling noise	Ann. de Chim. et de Phys. t. xxxiii. p. 403.
—— Feb. 3.	Lurroe in Norway	One shock	On the 3rd, 4th, and 5th, a violent storm raged in the German Ocean.		Keilhau.
—— —— 4.	Ditto	Ditto			Ditto.
—— —— 5.	Ditto	Ditto			Ditto.
—— —— 7.	Ditto	Ditto			Ditto.
—— —— 18. 8h 15m P.M.	Sienna in Tuscany	An undulatory shock, lasting four seconds. Followed, three minutes after, by a second, slighter. A third, still more feeble, occurred at 1 A.M.		During the first shock the bells rang in the upper stories of the houses, and a loud noise was heard, apparently coming from the west. The sky was obscured by clouds, and a very fine rain fell. The barometer was very high, and about 10 P.M. the sky became clear.	Ann. de Chim. et de Phys. t. xxxiii. p. 408; Férussac, Bull. des Sc. Nat. t. v. p. 107, quoting Antologia di Fiorenza, 1825, Fév. p. 136.
—— —— 21. 0h 30m A.M., 4 A.M., and 7 A.M.	Neighbourhood of St. Veit near Klagenfurth in Carinthia. Most strongly felt through the Glanthal as far as Wieting and Eberstein. The motion did not extend far.	The first shock was very slight; the second was more severe and lasted several seconds; and the third was again but slight. Direction = S.W. to N.E.		The second shock was severe enough to injure buildings, &c. The third was accompanied by subterranean noise like thunder. Horses, dogs, and birds showed symptoms of fear.	Klagenfurter Zeitung; Preuss. Staatszeitung, 1825, Nr. 57. S. 227.
—— —— 21. 6h 30m P.M., and about 11h 30m P.M.	Ditto	Two more slight shocks.			Journ. des Débats, 14 Mars.

1.	2.	3.	4.	5.	6.
1825. Feb. ...	Island of Meleda in the Adriatic.	Four violent shocks during the month, and several slighter disturbances.		On February 8, 12, 13, 15, 16, 18, 19, 22, 26, and 28, the peculiar detonations were heard in this island.	Paul Partsch, Bericht, u.s.w.
—— —— Between 7 and 8 P.M.	On board the ship 'Recovery,' on her voyage from Madeira to Honduras, near the island of Raatan in Honduras Bay.	A shock which seemed as if the vessel had struck on a bank.		During very gloomy weather. Said to have been felt also at the same time at Balize on the peninsula of Yucatan.	Edinburgh Journal of Science, 1826, Jan. p. 70.
—— Mar. 2. 10^h 42^m A.M.	Algiers and the country about, lying in a line from N.E. to S.W., or from Algiers towards the Canary Isles.	Violent undulatory motion, lasting 55 seconds. During the next four days ten more shocks of less violence were felt.		Some hours before this first shock all the springs and wells dried up. Great damage was done at Algiers, and the town of Blida, eight miles to the S.W., was almost entirely ruined, 7000 (or, according to others, 15,000) persons losing their lives. Near Blida also two hills are said to have been thrown together, and a village buried between them.	Moniteur et Constitutionnel, 28 Avril; Allgemeine Zeitung, 1825, Nr. 107; Ann. de Chim. et de Phys. t. xxx. p. 413; Monthly Magazine, vol. lx. Nr. 417. p. 463.
—— —— 14. 4 P.M.	Turin, Rivoli, &c.	A slight shock			Journ. de Savoie, 1825, Avril, p. 254; Ann. de Chim. et de Phys. t. xxxiii. p. 408.
—— April 6.	Saldenhofen in Styria	Vibratory shock		Accompanied by noise like thunder	Wiener Zeitung, 1825, 25 Avril.
—— —— 10.	Sala in Principato Ulteriore, kingdom of Naples.	Slight vibratory shock from W. to E.			Kastner's Archiv, B. xiv. S. 318.
—— —— 11. 8^h 15^m A.M.	Lagonegro in the Basilicata, kingdom of Naples. Also felt at several other places, especially at Papasidero.	Undulatory, more severe than the last, of four seconds' duration, and ending with a vertical shock.		The Ann. de Chim. et de Phys. gives the date April 14.	Ditto.
—— —— —— 4 P.M.	Caraccas in S. America.	A violent shock			Ann. de Chim. et de Phys. t. xxx. p. 413; Moniteur, 15 Juin; Journ. des Débats, 14 Juin.
—— —— 17.	Lunröe in Norway	Four trifling shocks			Keilhau.
—— —— ...	Islands of Sumbava, Java, Borneo, and Celebes.	A violent earthquake, lasting eleven days in Sumbava.		The earthquake ended in Sumbava by an eruption of the volcano Tombore, which covered part of the island with pumice. Many of the harbours were ruined, and about 12,000 men lost their lives.	Froriep's Notizen, B. xx. Nr. 8. (Nr. 426.) S. 114, quoting van Boon, Mesck.

1825. May 1. 11 A.M. and 2 P.M.	Modica near Syracuse in Sicily.	Slight shocks. The first was the most severe, and lasted two or three secs.		The Ann. de Chim. et de Phys. give the shocks as occurring at 11 P.M. on the 1st and 2 A.M. on the 2nd.	Kastner's Archiv, B. xiv. S. 321.
—— —— 3. Soon after midnight (of the 2nd?)	Aquila in the Abruzzo Ulteriore.	A slight shock, followed by a second at 4 P.M.			Ann. de Chim. et de Phys. t. xxxiii. p. 408.
—— —— 24. 3h 30m and 9h A.M. (P.M. according to the Ann. de Chim. et de Phys.).	Catanzaro in Calabria Ultra.	Two shocks, each lasting three seconds.			Ditto; Kastner's Archiv, *loc. cit.*
—— —— 28. 3 P.M.	Ditto	Another slight shock			Ditto.
—— —— At the end of the month.	At Mexico			Accompanied by subterranean rolling noise. The shock was considered but a common and little remarkable event by the inhabitants.	Hertha, B. v. 1826; Geogr. Zeitg. S. 72.
—— June 7. At night.	Smyrna	A slight shock, lasting three seconds.			Ann. de Chim. et de Phys. t. xxxiii. p. 409.
—— —— 12. 2 A.M.	In Chili (at Valparaiso or Santiago?).	A severe shock			Ditto t. xlii. p. 407.
—— July 2.	Algiers and neighbourhood.	Very severe shocks, which recurred for several days.		v. Hoff seems to think this account is merely that of March 2 wrongly given as to the date of the month.	Ditto, t. xxx. p. 413; Moniteur et Constitutionnel, 19 Juillet.
—— —— 7.	Faenza in Italy	A slight shock			Moniteur, 28 Juillet.
—— —— 21.	Pawlowsk in the government of Woronesch. Russia.	An earthquake	The river Don was in a state of violent agitation, as if disturbed by a storm.	Accompanied by subterranean noise like a cannonade at a distance. All the furniture in the houses lying on the right bank of the Don was shaken about.	Allgemeine Zeitung, 1825, Nr. 252. S. 1008.
—— —— 25.	Rossano in Calabria Citra.	A slight earthquake		Unproductive of any damage. Heavy rain had lately fallen.	Preuss, Staatszeitung, 1825, Nr. 218. S. 871.
—— —— 27.	Orsomarso in the same province.	Ditto		Ditto. All the springs, &c. to the distance of half a mile (Italian?) from Orsomarso dried up. On the 26th and 27th, one of the most tremendous hurricanes on record occurred in the West Indies.	Ditto.
—— Aug. 2.	Algiers			This account refers, in all probability, to the same event as that given on the 2nd July, the latter being the correct date.	Gentleman's Magazine, vol. xcv. pt. 2. p. 172.

1.	2.	3.	4.	5.	6.
1825. Aug. 17. Between 10 and 11 A.M.	Nieder-Beerbach in Hesse Darmstadt.	Several shocks ……	………………………	Windows rattled, and doors, stoves, &c. were set in motion.	Gothaische Zeitung, 1825, Nr. 136.
—— —— 20. 4 A.M.	Kingston in the island of St. Vincent, West Indies.	Two severe shocks, with scarcely any interval.	………………………	………………………………………………	Moniteur, 18 Oct.; Ann. de Chim. et de Phys. t. xxxiii. p. 409.
—— —— 21. About 9 P.M.	Cairo in Egypt ………	Four rather severe shocks. They seemed to come from due north.	………………………	The Egyptians attributed these shocks to the comet which appeared in the following October.	Eyriès, Nouv. ann. des Voyages, t. xxviii. Déc. 1825, p. 428.
—— —— 26. $3^h 15^m$ A.M.	Leghorn ………………	Two distinct undulations.	………………………	………………………………………………	Moniteur, 8 Sept.; Ann. de Chim. et de Phys. t. xxxiii. p. 408.
—— —— —— $5^h 15$ or 20^m A.M.	Ditto, and at Genoa …	At Leghorn a slight undulation from E. to W. At Genoa the shock was very strong, and lasted 5 or 6 seconds.	………………………	………………………………………………	Ditto.
—— Sept. 1. $9^h 48^m$ P.M.	Harbour of Peter and Paul, Kamtschatka.	An earthquake, of 9 secs. duration.	………………………	………………………………………………	Allgemeine Zeitung, 1826, Nr. 205. S. 820.
—— —— 7.	Orsomarso in Calabria Citra.	A slight shock………	………………………	A spring which rose half a mile from the place ceased to flow. The account probably refers only to the same event as that given on 27th July.	Ann. de Chim. et de Phys. *loc. cit.*
—— —— 20. 10 P.M.	Demerara in the north of S. America. Also felt at the same time in the islands of Barbadoes and Trinidad.	The most severe shock felt for many years in Demerara. It was oscillatory, in the direction W.N.W. to E.S.E., and lasted 3 or 4 minutes (secs.?). Followed by a slighter shock an hour afterwards.	The sea was agitated by an oscillatory motion analogous to that felt on shore.	Accompanied in Demerara by a dull heavy noise. There was a light wind from the N.W.; the atmosphere was clear about the zenith, but clouded in the northern horizon. The second shock was attended by a sudden gust of wind. In the island of Trinidad several houses were thrown down.	Allgem. Konst en Letterbode, 1825, 2 Dec.; Ann. de Chim. et de Phys. t. xxx. p. 412.
—— Oct. 3.	In the West Indies (in which island is not mentioned).	A vibratory shock …	………………………	………………………………………………	Leonhard's Zeitschrift, 1826, B. ii. S. 360.
—— —— 5. $3^h 32^m$ A.M.	Harbour of Peter and Paul, Kamtschatka.	An earthquake, of 3 secs. duration.	………………………	………………………………………………	Allgemeine Zeitung, 1826, Nr. 205. S. 820.

1825. Oct. 23. About 8h and 8h 30m P.M.	Aquila in the Abruzzo, kingdom of Naples.	The first shock was very severe, and of rather long duration. The second was slighter.		Oct. 17–20, the barometer was unusually low in N. Germany, and it blew a violent storm.	Kastner's Archiv, B. xiv. S. 323; Ann. de Chim. et de Phys. t. xxxiii. p. 408.
—— —— 24. 3 A.M.	Ditto	Another shock, followed by three more during the ensuing evening and night.			Ditto.
—— —— Towards the end of the month.	Schiraz in Persia	A shock almost as severe as that of the year before.		Numbers of buildings were reduced to ruins	Madras Courier, Journal Asiatique, 1826, Jun. 3. p. 800; Monthly Magazine, 1826, July, p. 74.
—— Nov. 7. 10h 33m A.M.	Harbour of Peter and Paul in Kamtschatka.	An earthquake of 20 secs. duration.			Allgemeine Zeitung, 1826, Nr. 205. S. 820.
—— —— 19. In the morning.	Port-au-Prince in Haiti.	Violent shocks, lasting four or five seconds. This is said to have been the third earthquake of the year.		Accompanied by a dull noise coming from the S.E.	Ann. de Chim. et de Phys. t. xxx. p. 413; Moniteur, 25 Janv. 1826.
—— —— 30.	In the West Indies. In which of the islands is not mentioned.	Shocks		The subterranean noise accompanying these shocks was more distinct, and louder than on former similar ocasions. Preceded for several days by heat of very unusual intensity for this time of year. Immediately after the earthquake the weather became cooler, and heavy rain with thunder set in and lasted for ten days.	Leonhard's Zeitschrift, 1826, B. ii. S. 360.
—— Dec. 8. Between 10 and 11 P.M.	Geneva	A severe shock			Journ. des Débats et Constitutionnel, 19 Déc.; Ann. de Chim. et de Phys. t. xxx. p. 414.
—— —— 23. 5 A.M.	Strasburg, Kehl, Sundheim, Neumühl, Kork, Offenburg, and very slightly at Mannheim.	Shocks, which were strongest at Strasburg, and were there in the direction N.E. to S.W., or N. to S. At Strasburg the watchman attached to the cathedral felt his bench shaken		At Strasburg the weather was calm and the sky overcast. A slight wind blew from the south. The barometer was at 27 in. 11 lines, about 2 lines below the mean height, and the thermometer at +1°·25 R. An extraordinary bellowing sound had been heard in the air between 3 and 4 A.M. Dec. 6–9, violent storms and inundations on the coasts of the Mediterranean and Adriatic.	Constitutionnel, 28 Déc.; Ann. de Chim. et de Phys. t. xxx. p. 414; Allgemeine Zeitung, 1825, Nr. 363. S. 1451 u. Beilage, Nr. 365; Preuss. Staatszeitung, 1826, Nr. 8. S. 33.

1.	2.	3.	4.	5.	6.
		about 4^h 45^m, and then three or four shocks ensued.			
1825. Dec. ...	Admont in the circle of Judenburg in Styria.	Slight shocks, which recurred from time to time up to the 15th May, 1826, when a violent earthquake took place.		Accompanied by subterranean noise	Leonhard's Zeitschrift, 1826, B. ii. S. 536.
1826. Jan. 7. 7 A.M.	Island of Martinique ...	An earthquake, consisting of two shocks; the one slight, the other violent.		The inhabitants were alarmed by the stronger shock of the two, but no damage was done.	Ann. de Chim. et de Phys. t. xxxiii. p. 412; Revue Encycl. Mars, p. 866.
—— —— 23.	Lunröe in Norway	A severe shock			Keilhau.
—— —— 26.	Prevesa in Albania	A violent shock		The town was much injured	Constitutionnel, 9 Mars; Ann. de Chim. et de Phys. t. xxxiii. p. 409; Allgemeine Zeitung, 1826, Nr. 63. S. 252.
—— ——	The most southern of the 'Isles de l'Archevêque,' islands lying to the south of Fatsisio, Bonin, &c.	A violent earthquake.		Accompanied by a hurricane or typhoon, which raised the sea twelve feet above its ordinary level.	v. Humboldt, Fragmens de Géologie et de Climatologie Asiatiques, t. i. p. 228; Beechey's Voyage to the Pacific (London, 1831), pt. 2. p. 513.
—— Feb. 1. 5 P.M. (3 P.M. according to v. Hoff.)	In the Basilicata, kingdom of Naples. Also (two shocks) felt at Naples and Avellino, the hour however not being given. The places shaken lie in a line running nearly due E. and W.	A shock, which was at first vertical, and then became horizontal, and undulatory from N. to S., and lasted more than 20 secs. Two other shocks followed, with an interval of half an hour.		Houses were thrown down in the commune of El Tito (Huot, in his 'Cours de Géologie,' records the earthquake at this place as occurring at the end of February), and Potenza also suffered. The weather had been cold and rainy up to the 29th January, but on the 1st February almost unbearable heat set in. Smoke issued for several days about this time from Vesuvius. V. Hoff gives a separate account, identical with this, on the 1st Feb. 1827, but there was probably but one earthquake, that here recorded.	Journ. des Débats, 21 Fév.; Moniteur, 24 Fév. et 7 Mars; Preuss, Staatszeitung, 1826, Nr. 55. S. 220.
—— —— 8. 8^h 30^m P.M.	Constantinople and (at same hour) Smyrna.	At Constantinople three severe shocks from N. to S. Du-			Constitutionnel, 31 Mars; Ann. de Chim. et de Phys. t. xxxiii. p. 409; Preuss, Staatszeitung, 1826, Nr.

		ring the night some other slight shocks were felt. At Smyrna the shock was but little remarkable.			61. S. 241; Allgemeine Zeitung, Nr. 89. S. 356.
1826. Feb. 21. 9 P.M.	Tornea in Lapland	An earthquake, lasting one minute. Direction = S. to N.		On the 20th it blew a violent storm from the south for nearly 24 hours. At the time of the earthquake the atmosphere was calm and clear. A sound which, at first dull and low, changed to an alarming rattling noise, accompanied the shock. Buildings shook.	Allgemeine Zeitung, 1826, Beil, Nr. 109. S. 433; Leonhard's Zeitschrift, 1826, B. ii. S. 426.
—— —— —	Lunröe in Norway	Another shock, probably at the same time as that at Tornea.			Keilhau.
—— —— 26.	Brieg in the Valais	Violent tremulous shocks; the most severe which had been felt at this place since 1817.		Preceded by a dull noise. The houses were shaken. It does not seem certain whether this event occurred in 1826 or 1827.	Férussac, Bull. des Sc. Nat. t. xii. p. 362.
—— Mar. 18. $0^h\ 20^m$ A.M.	Pesaro in the States of the Church.	A rather severe shock from S.E. to N.W.	The sea was a little agitated.		Ann. de Chim. et de Phys. t. xxxiii. p. 408; Archives des Découvertes, 1826, p. 193.
—— —— — $0^h\ 40^m$ P.M.	Ditto	A more intense shock.	At the time of the shock the sea was observed to be in a state of great agitation near Sinigaglia, although the air was calm. The sand mixed with the water destroyed its transparence to the distance of two miles from the shore.		Ditto.
—— —— — $1^h\ 14^m$ P.M.	Ditto	A slight shock			Ditto.
—— —— — $2^h\ 4^m$ P.M.	Ditto	Ditto		v. Hoff gives the hour $4^h\ 2^m$	Ditto.

1.	2.	3.	4.	5.	6.
1826. Mar. 18. $10^h 45^m$ P.M.	Pesaro in the States of the Church.	A slight shock			Ann. de Chim. et de Phys. t. xxxiii. p. 408 ; Archives des Découvertes, 1826, p. 193.
—— —— 19. $1^h 45^m$ A.M.	Ditto	Rather slight, from S.E. to N.W.			Ditto.
—— —— — $3^h 15^m$ A.M.	Ditto	Ditto			Ditto.
—— —— 20. $1^h 50^m$ A.M.	Ditto	Ditto, rather prolonged.			Ditto.
—— —— 22.	Lunröe in Norway	Another shock			Keilhau.
—— —— 26. $2^h 30^m$ P.M.	Kremsmünster in the circle of Traun, Austria. Also felt (at same time) at Vöcklabruck, 4 miles further to the W. by S., and in the neighbourhood.	Some slight shocks. The first seemed to move in a north-westerly direction (*from* or *to* N.W.?), and was rather horizontal. The other shocks seemed to be more vertical.		Principally felt in the upper stories of the houses. Boxes and furniture were shaken about. No change in the height of barometer or thermometer was observed. There was a light wind from the N.E., and the sky was clouded, but cleared up in the evening.	Preuss. Staatszeitung, 1826, No. 92. S. 367.
—— Apr. 3. 2 P.M.	Admont in the circle of Judenburg in Styria.	A distinct shock		The walls of the chapter-house rocked. The noise was very distinct. Wind westerly, with a clear atmosphere.	Leonhard's Zeitschrift, 1826, B. ii. S. 536.
—— —— 6. $4^h 20^m$ A.M. (v. Hoff says $1^h 20^m$.)	Pesaro in the States of the Church.	Another slight shock, said to be from S.W. (S.E.?) to N.W.			Ann. de Chim. et de Phys. t. xxxiii. p. 408; Archiv. des Découv. 1826, p. 193.
—— —— —	Palermo	A shock			Poggendorff's Annalen, B. xxiv. S. 54.
—— —— 14. 5 P.M.	St. Brieux in the departm. Côtes du Nord, and the neighbourhood.	A shock from E. to W., lasting 12 or 15 secs.		Preceded by a noise like that of a carriage rolling over stones.	Ann. de Chim. et de Phys. t. xxxiii. p. 410; Férussac, Bull. des Sc. Nat. t. viii. p. 329.
—— —— 22. $10\frac{1}{2}$ A.M.	Santiago in Chili	A severe shock			Garnier, Météorologie, p. 148.
—— —— —	In Granada, Spain	A violent earthquake.		This account is said by v. Hoff to be doubtful	Keferstein's Geognostische Zeitung, St. 4. S. 112.
—— —— —	Lunröe in Norway	Another shock			Keilhau.
—— —— 25. $3^h 30^m$ P.M.	Jelisabethpol or Hamsha, 158 wersts from Tiflis in Georgia.	A severe vibratory shock, lasting 20 secs.		Accompanied by subterranean noise. No damage done.	Preuss. Staatszeitung, 1826, Nr. 192. S, 767.

1826 May 2. 0h 35m A.M.	Island of Martinique	A shock of remarkably long duration, and severe enough to waken all who were asleep.			Revue Encycl. Juillet, p. 236.
—— —— 15. A little before 3 A.M.	Admont in the circle of Judenburg in Styria. Also on this day at Gräz, thirteen geographical miles to the S.E. of Admont.	A severe earthquake. The first strong shock was succeeded by oscillations which, at first rather violent, gradually became weaker. The earthquake seemed to come from the east, from the neighbourhood of Gsäus, and extended to Rottenmann (two (German?) miles to the S.W.) and Gallenstein. At Gräz the shock was rather severe, and recurred eight times before the end of May.		Preceded by a low subterranean noise which constantly increased in distinctness. A loud noise like the explosion of a piece of heavy ordnance at a distance accompanied the first shock. Clocks were thrown down, and persons who were asleep were thrown out of their beds. The air was calm, and the sky overcast with thick clouds, which sank in large masses into the valley. The day before, the heavens had been clear, but in the evening a strong east wind blew at the level of the tops of the trees, though but little felt at the surface of the ground. At Gräz one of the shocks felt during this month was accompanied by a loud noise, and caused the people to leave their houses.	Leonhard's Zeitschrift. 1826, B. 2. S. 536; Geraische Zeitung, 1826, Nr. 93.
—— —— — 11 A.M.	Granada in Spain	Several shocks. Others followed on this and the next day.		Preceded by loud subterranean noise. The other shocks of the 15th and 16th were unattended with noise. Rain, and cold wind.	Journ. des Débats, 5 Juin; Ann. de Chim. et de Phys. t. xxxiii. p. 410. Arch. des Découv. 1826, p. 193; Allgemeine Zeitung, 1826, Nr. 160. S. 638.
—— —— 17. About dawn.	Ditto	A very violent shock, followed twenty minutes later by another of 3 seconds' duration. Other, but slighter shocks were felt during the day, and several occurred before the end of the month.		Accompanied by a terrible bellowing noise. Several buildings were more or less injured.	Ditto; Preuss, Staatszeitung, 1826, Nr. 141. S. 563.

1.	2.	3.	4.	5.	6.
1826. Mar. 18. $10^h 45^m$ P.M.	Pesaro in the States of the Church.	A slight shock	......	......	Ann. de Chim. et de Phys. t. xxxiii. p. 408; Archives des Découvertes, 1826, p. 193.
—— —— 19. $1^h 45^m$ A.M.	Ditto	Rather slight, from S.E. to N.W.	......	......	Ditto.
—— —— —— $3^h 15^m$ A.M.	Ditto	Ditto	......	......	Ditto.
—— —— 20. $1^h 50^m$ A.M.	Ditto	Ditto, rather prolonged.	......	......	Ditto.
—— —— 22.	Lunröe in Norway	Another shock	......	......	Keilhau.
—— —— 26. $2^h 30^m$ P.M.	Kremsmünster in the circle of Traun, Austria. Also felt (at same time) at Vöcklabruck, 4 miles further to the W. by S., and in the neighbourhood.	Some slight shocks. The first seemed to move in a north-westerly direction (*from* or *to* N.W.?), and was rather horizontal. The other shocks seemed to be more vertical.	......	Principally felt in the upper stories of the houses. Boxes and furniture were shaken about. No change in the height of barometer or thermometer was observed. There was a light wind from the N.E., and the sky was clouded, but cleared up in the evening.	Preuss. Staatszeitung, 1826, No. 92. S. 367.
—— Apr. 3. 2 P.M.	Admont in the circle of Judenburg in Styria.	A distinct shock	......	The walls of the chapter-house rocked. The noise was very distinct. Wind westerly, with a clear atmosphere.	Leonhard's Zeitschrift, 1826, B. ii. S. 536.
—— —— 6. $4^h 20^m$ A.M. (v. Hoff says $1^h 20^m$.)	Pesaro in the States of the Church.	Another slight shock, said to be from S.W. (S.E.?) to N.W.	......	......	Ann. de Chim. et de Phys. t. xxxiii. p. 408; Archiv. des Découv. 1826, p. 193.
—— —— ——	Palermo	A shock	......	......	Poggendorff's Annalen, B. xxiv. S. 54.
—— —— 14. 5 P.M.	St. Brieux in the departm. Côtes du Nord, and the neighbourhood.	A shock from E. to W., lasting 12 or 15 secs.	......	Preceded by a noise like that of a carriage rolling over stones.	Ann. de Chim. et de Phys. t. xxxiii. p. 410; Férussac, Bull. des Sc. Nat. t. viii. p. 329.
—— —— 22. $10\frac{1}{2}$ A.M.	Santiago in Chili	A severe shock	......	......	Garnier, Météorologie, p. 148.
—— —— ——	In Granada, Spain	A violent earthquake.	......	This account is said by v. Hoff to be doubtful...	Keferstein's Geognostische Zeitung, St. 4. S. 112.
—— —— ——	Lunröe in Norway	Another shock	......	......	Keilhau.
—— —— 25. $3^h 30^m$ P.M.	Jelisabethpol or Hamsha, 158 wersts from Tiflis in Georgia.	A severe vibratory shock, lasting 20 secs.	......	Accompanied by subterranean noise. No damage done.	Preuss. Staatszeitung, 1826, Nr. 192. S. 767.

[illegible] May [illegible]. 0^h 35^m A.M.	Island of Martinique ...	A shock of remarkably long duration, and severe enough to waken all who were asleep.	....	....	Revue Encycl. Juillet, p. 236.
——— 15. A little before 3 A.M.	Admont in the circle of Judenburg in Styria. Also on this day at Gräz, thirteen geographical miles to the S.E. of Admont.	A severe earthquake. The first strong shock was succeeded by oscillations which, at first rather violent, gradually became weaker. The earthquake seemed to come from the east, from the neighbourhood of Gsäus, and extended to Rottenmann (two (German?) miles to the S.W.) and Gallenstein. At Gräz the shock was rather severe, and recurred eight times before the end of May.	....	Preceded by a low subterranean noise which constantly increased in distinctness. A loud noise like the explosion of a piece of heavy ordnance at a distance accompanied the first shock. Clocks were thrown down, and persons who were asleep were thrown out of their beds. The air was calm, and the sky overcast with thick clouds, which sank in large masses into the valley. The day before, the heavens had been clear, but in the evening a strong east wind blew at the level of the tops of the trees, though but little felt at the surface of the ground. At Gräz one of the shocks felt during this month was accompanied by a loud noise, and caused the people to leave their houses.	Leonhard's Zeitschrift. 1826, B. 2. S. 536; Geraische Zeitung, 1826, Nr. 93.
——— — 11 A.M.	Granada in Spain	Several shocks. Others followed on this and the next day.	....	Preceded by loud subterranean noise. The other shocks of the 15th and 16th were unattended with noise. Rain, and cold wind.	Journ. des Débats, 5 Juin; Ann. de Chim. et de Phys. t. xxxiii. p. 410. Arch. des Découv. 1826, p. 193; Allgemeine Zeitung, 1826, Nr. 160. S. 638.
——— 17. About dawn.	Ditto	A very violent shock, followed twenty minutes later by another of 3 seconds' duration. Other, but slighter shocks were felt during the day, and several occurred before the end of the month.	....	Accompanied by a terrible bellowing noise. Several buildings were more or less injured.	Ditto; Preuss, Staatszeitung, 1826, Nr. 141. S. 563.

1.	2.	3.	4.	5.	6.
1826. May 20.	Lunröe in Norway	Another shock	....	....	Keilhau.
—— June. During the first few days of the month.	Granada in Spain	Some more slight shocks.	....	....	Journ. des Débats, 7 Août; Moniteur, 2 et 8 Août; Ann. de Chim. et de Phys. t. xxxiii. p. 410; Arch. des Découv. 1826, p. 194.
—— —— 4. 7h 45m P.M.	Potenza in the Basilicata, kingdom of Naples. Felt at the same time in the Campagna in Principato citeriore, ten geographical miles to the west, and more slightly at Salerno, fourteen miles in the same direction.	Slight undulatory shock from N. to S., lasting about twelve seconds.	....	The places shaken on this occasion lay in the same line as those at which the earthquake of February 1 was felt.	Preuss, Staatszeitung, 1826, Nr. 152. S. 606; Moniteur, 28 Juin.
—— —— 12. 5h 10m A.M.	Smyrna. About this time severe shocks were also felt in the island of Metellino in the Archipelago.	An earthquake, lasting thirty seconds.	....	....	Preuss, Staatszeitung, 1826, Nr. 208. S. 832; Leonhard's Zeitschrift, 1826, B. 2. S. 539; Férussac, Bull. des Sc. Nat. t. xi. p. 30.
—— —— 17. 10h 45m P.M.	Santa Fé-de-Bogota in Columbia, S. America.	A violent earthquake. The first shock was followed twenty seconds later by a second, of greater violence, lasting forty or forty-five secs. The latter was in a horizontal direction from S. to N. M. Boussingault says that the *first* shock was in this direction and lasted eight seconds, and that the second was at first from W. to E., and then changed to violent undulatory mo-	....	The second shock greatly injured many churches and other buildings, several of which fell on the following day. In a desert place, on the Cerro-Cedro, one mile S.W. from the town, a cleft opened of 200 feet wide, from which there arose sulphurous vapours. The motion was so violent that M. Boussingault compares it to that of a boat on a stormy sea, and says that he with difficulty descended the stairs of his house during the second shock. The slight shock felt at midnight was accompanied by a dull noise coming from the east. This earthquake, the most violent felt here since 1805, was preceded by long-continued drought, and immediately followed by very heavy rain. At the time of the shock the heavens were clouded and the air quite calm.	Moniteur, 1826, Nr. 246 et 254; Allgemeine Zeitung, 1826, Nr. 252, u. 260; Journal Columbus, B. ii. S. 429; Archiv. des Découv. 1826, p. 194; Garnier, Météorologie, p. 149.

		tion. About midnight another slight movement was perceived.			
1826. May 18.	Potenza in the kingdom of Naples.	A slight shock like that of the 4th, lasting ten seconds.	....	....	Preuss, Staatszeitung, 1826, Nr. 166. S. 663.
—— —— 19.	Santa Fé-de-Bogota ...	Some slight shocks. M. Boussingault observed by means of his declination needle that the earth was still in a state of almost constant motion.	....	....	Moniteur, &c., as above.
—— —— 20. 11 A.M.	Ditto	Another very distinct shock. The motion was horizontal, from S. to N., and lasted some seconds.	....	....	Ditto.
—— —— 21. At night.	Ditto	Some more oscillations.	....	....	Ditto.
—— —— 22. 4h 45m A.M.	Ditto	Violent oscillations, horizontal and in the same direction as before, lasting 25 or 30 secs. From the 22nd to the 29th some more slight movements of the earth were perceived.	....	A part of the hospital was thrown down	Ditto.
—— —— 23. 1h 30m or 2h 30m P.M.	Venice	Two slight shocks ...	....	....	Allgemeine Zeitung, 1826, Nr. 192. S. 767; Journ. des Débats, 10 Juillet; Férussac, Bull. des Sc. Nat. t. xii. p. 215, t. xv. p. 247.
—— —— — 8h 30m P.M.	Innsbruck	Ditto	....	....	Ditto; Preuss, Staatszeitung, 1826, Nr. 158, S. 631, Nr. 164, S. 656, Nr. 166, S. 663; Gothaische Zeitung, Nr. 111 u. 116; Leonhard's Zeitschrift, 1826, B. ii. S. 478, 1827, B. i. S. 86.

1.	2.	3.	4.	5.	6.
1826. May 24. 4^h 30^m A.M.	Innsbruck	A much stronger shock. The motion undulatory.	....	Accompanied by loud noise. Articles of furniture were rather violently thrown about.	Authorities quoted above (on the 23rd).
——— — At Trente and Roveredo, 1^h 20^m P.M. At Brixen, $1^h 26^m$ P.M. (According to other accounts the shocks at these places happened at the same time as at Innsbruck. At Mantua, 1^h 15^m P.M., and on the lake of Zürich about 2 P.M.	Trente, Roveredo, Brixen, Mantua, places on the lake of Zürich, as Wadenschwyl, Stöfa, and in the Seefeld near Zürich, and elsewhere in the Tyrol, Switzerland, and Upper Italy.	At Trente the shock was undulatory, and lasted two seconds, in the direction E. to S. (?) At Roveredo the motion was slight, undulatory, from S.E. to N.W., and lasted fifteen seconds. At Brixen there were three shocks, from S. to N., the third of which was the most violent. At Mantua, a slight earthquake of some seconds' duration.	....	At Trente accompanied by a gust of wind from the S., after which a gentle and somewhat cooler breeze blew up to 5 P.M. The sky was quite cloudless before the shock, but after it clouds gradually collected. The barometer fell at the moment of the shock 1·3 line, and went up again (in what time ?) after it within 5 lines of its former height. At Brixen the weather had been windy for several days before, but during the shocks a perfect calm prevailed, after which the wind rose again, and warm weather followed. v. Hoff remarks that the places at which this earthquake was felt lie in a line running almost exactly N. and S., and concludes that the centre of disturbance lay between Brixen and Trente. The accounts vary considerably as to the hours at which the different shocks occurred. Probably those given for the 23rd at Venice and Innsbruck really occurred on the 24th, and perhaps 1^h 30^m or 2^h 30^m on that day is the correct time for all.	Ditto.
——— —	St. Brieux in the departm. Côtes du Nord.	One shock	....	....	Férussac, Bull. des Sc. Nat. t. xv. p. 247.
——— —— and July.	Granada in Spain	Frequent slight shocks	....	....	Allgemeine Zeitung, 1826, No. 206. S. 822; Preuss, Staatszeitung, 1826. Nr. 187, S. 751; Moniteur, Nr. 220, p. 1156.
—— July 4.	Ditto	Two shocks	....	....	Journ. des Débats, 7 Août; Moniteur, 2 et 8 Août; Ann. de Chim. et de Phys. t. xxxiii. p. 410.
——— 16.	Ditto	Three shocks	....	....	Ditto.
——— 17.	Ditto	More shocks	....	....	Ditto.
——— 21.	Lunröe in Norway	Another shock........	....	....	Keilhau.
—— Aug. 10.	Palermo in Sicily	A shock	....	....	Poggendorff's Annalen, B. xxiv. S. 54.

1826. Aug. 12. 5 A.M.	St. Pierre in the island of Martinique, and in Guadeloupe.	Two very severe shocks with scarcely any interval.		No damage done	Moniteur, 5 Oct.; Journ. des Débats et Constitutionnel, 4 Oct.
—— —— 18. 0h 40m A.M.	Jamaica, in Mondego Bay.	Two rather severe shocks.	A violent tempest soon after in the West Indian sea.	Some buildings were injured	Moniteur, 16 Oct.; Columbus, B. ii. S. 429.
—— —— 19. 8h 30m A.M.	Bender near Odessa, Russia.	A slight vibration, lasting 15 seconds.			Journ. des Débats, 24 Oct.
—— —— 31. 11 A.M.	Nicastro in Calabria Ultra.	Two severe shocks			Leonhard's Zeitschrift, 1827, B. i. S. 250.
—— Sept. 1.	Monteleone, five geographical miles S. by W. from Nicastro.	A slight trembling			Ditto.
—— —— 7.	Lunröe in Norway	Another shock			Keilhau.
—— —— 16. About 10h 30m A.M.	St. Jean de Boiseau in the department Loire-Inférieure.	Two slight shocks, from S.W. to N.W. (?).			Journ. des Débats, 28 Sept.
—— —— 18. Between 3 and 4 A.M.	St. Jago in Cuba. Also felt, though more slightly, at Kingston in Jamaica.	Three shocks, of which the second was the most severe. Each lasted nearly a minute.		Accompanied by loud noise, which at first resembled the rolling of a waggon over stones, and ended with an explosion as of a large number of heavy pieces of artillery. The weather was unbearably hot. Half the town of St. Jago was destroyed.	Allgemeine Zeitung, 1826, Nr. 339; Atlantis, by Rivinus, B. i. 1827, S. 68; Ann. de Chim. et de Phys. t. xxxiii. p. 412; Moniteur et Constitutionnel, 30 Nov.
—— —— 28. 1h 30m A.M.	Innsbruck in the Tyrol.	Violent undulatory shock.		Accompanied by noise like thunder	Leonhard's Zeitschrift, 1827, B. i. S. 250.
—— —— ...	In the province of Otranto, Italy.	Several shocks during the month.			Ann. de Chim. et de Phys. t. xxxiii. p. 408.
—— Oct. 1.	Ofen, Pesth, Pilis, Monor, and Giömrö, in Hungary.	Violent shocks felt at the same time at these different places.			Leonhard's Zeitschrift, 1827, B. i. S. 261.
—— —— 13.	Santiago in Chili	A severe shock		Equal in intensity, though not in destructive effects, to the shock of the 19th of Nov. 1822.	Garnier, Météorologie, p. 151.
—— —— In the middle of the month.	In the mountains of Praauw (Prahu ?), in Java.	Severe shocks		On the 11th the mountain Paköwodjo had *burst*. Similar phænomena took place in the mountains of Klut, but whether any eruption occurred is not mentioned.	Leonhard's Zeitschrift, 1827, B. i. S. 566.
—— —— 15.	Savannah in Georgia, United States.	A violent earthquake.	On the same day it blew a terrible gale of wind from the north, which forced many ships to put into harbour.		Constitutionnel, 2 Déc.

1.	2.	3.	4.	5.	6.
1826. Oct. Night between 15 and 16.	Catanzaro in Calabria Ultra, and Messina in Sicily.	Several shocks			Journal de Savoie, 1826, 10 Nov. p. 1089.
—— —— 26.	Naples and in the province of Bari.	A shock, apparently in the direction N.E. to S.W.			Moniteur, 29 Nov.
—— —— 27. 11 A.M.	Isernia in the province of Molise, kingdom of Naples. And, about the same time, at Aquila in the Abruzzo Ulteriore.	Several shocks			Ditto; Kastner's Archiv, B. xiv. S. 323.
—— —— 29.	Cosenza in Calabria Citra.	Two severe shocks			Moniteur, 29 Nov.; Keferstein's Geogn. Zeitung, St. 4. S, 103.
—— Nov. 5.	Lunröe in Norway	Another slight shock.			Keilhau.
—— —— 26. 4 P.M.	Island of Arran, between Scotland and Ireland.	A shock of three or four seconds' duration.		Accompanied by a rattling noise. The sky was clear, and there was but little wind at the time.	Edinburgh Journal of Science, vol. vi. p. 370.
—— —— 27.	Trente in the Tyrol	A vibration		This account v. Hoff considers doubtful	Kastner's Archiv, B. xiv. S. 244.
—— Dec. 14. 4h 30m A.M.	Granada in Spain	A violent shock. A few moments after, four slighter shocks were felt, and at 8 P.M. a very severe one.		Many persons were thrown out of their beds	Gothaische Zeitung, 1827, Nr. 10; Moniteur, 10 Janv. 1827; Férussac, Bull. des Sc. Nat. Avril, 1828, p. 396.
—— —— 15. 8h 45m P.M. Innsbruck and the valley of Montafon 9 P.M. is given as the time. At Zürich, Lindau, Coire, Schaffhausen, and Winterthur, *about* 8h30m.	At Innsbruck, in the whole valley of Montafon in the Tyrol, at Augsburg, Lindau, Coire, Winterthur, Schaffhausen, and Zürich. Also at St. Gall and Herisau. The limits of the earthquake seem to have been Zürich on the west, and Innsbruck on the east.	Shocks, more or less severe at the different places named. In Innsbruck and the Montafon. That two violent vibrations, following rapidly one on the other, were observed, the direction being N. to S. At Augsburg the motion was considerable, undula-		At Zürich the shock was not felt in every part of the town. Windows rattled, the pendulums of clocks were disturbed, and wainscot cracked.	Moniteur, 3 Janv. 1827; Allgemeine Zeitung, 1827, Nr. 1. S. 3; Gothaische Zeitung, 1826, Nr. 206, 1827, Nr. 11.

		tory from E. to W., lasting some seconds. At Zürich a slight shaking motion had been observed between 7 and 8 P.M., like a gust of wind. The direction of the principal shock was said to be N.E. to S.W. At 3 A.M. on the 16th another was perceived.			
1826. Dec. 16. 5h 39m P.M.	Innsbruck	Another shock, lasting thirty seconds.		Accompanied by noise like thunder	Leonhard's Zeitschrift, 1827, B. i. S. 341.
—— —— 25. 2 P.M.	Ardvoirlich (Lough Erne) in Scotland, and at the same hour at Leadhills.			The sound which preceded the shock was like that of a blast in a quarry. The day was warm, thick, and hazy. On the 30th of this month a small river in East Gothland, Sweden, suddenly stopped at a particular place, so that it could be passed dryshod, but there seems nothing to prove that this was caused by any earthquake shock.	Kastner's Archiv, B. xiv. S. 192; D. Milner's Catalogue of British Earthquakes, *loc. cit.*
1827. Jan. 2. (Jan. 1 according to v. Hoff.) "à l'heure du diner." At Essonne and Corbal, at 3h 45m P.M.	Montagne (department de l'Orne), Alençon, and neighbourhood. Also at Essonne and Corbeil in the department Seine-et-Oise.	A violent shock, though of short duration.		Accompanied at Montagne and Alençon by a very loud noise. Chimneys were thrown down, and panes of glass broken. The sky was clouded, and the weather lowering and stormy.	Journ. des Débats, 12 Janv.; Constitutionnel, 10 Janv.; Ann. de Chim. et de Phys. t. xxxvi. p. 398.
—— —— 14.	Near Wagstadt in Silesia.	A shock		After the shock a piece of land of about 3000 square klafters in extent sank seven feet. From the 14th to the 17th a tremendous storm raged over England, Holland, Germany, and Prussia.	Gothaische Zeitung, 1827, Nr. 35.
—— —— In the middle of the month.	Calcutta	An earthquake			Hamburg Corresp. 1827, Nr. 94.
—— —— ...	In the Crimea	Ditto			Kastner's Archiv, B. xiv. S. 244.

1.	2.	3.	4.	5.	6.
1827. Feb. 9. 7 P.M.	In the island of Anglesea, and the north-west part of Wales. Also at Ripon in Yorkshire.	Lasted forty seconds to one minute.		Accompanied in Wales by a noise like that of a cart laden with stones. Furniture was overturned. At Ripon a tremendous explosion was heard, which shook the whole neighbourhood. A fissure was formed, nearly twenty yards wide, and twenty-four yards deep.	Phil. Mag. N. S. vol. iii. p. 463; D. Milne's Catalogue, *loc. cit.*; Ann. de Chim. et de Phys. t. xxxvi. p. 399.
— — 11.	El Zito in the Basilicata, kingdom of Naples.	A violent shock			Kastner's Archiv, B. xiv. S. 324.
— — 18. 7^h 15^m A.M.	Aquila and Zeramo, kingdom of Naples.	Tremblings		Unproductive of any damage	Ditto, S. 326.
— Mar. 7.	Lunröe in Norway	Another shock			Bull. de la Soc. Géol. t. vii. p. 21.
— — In the middle of the month.	Leghorn. Also felt at Sinigaglia.	Slight tremblings from time to time for eight successive days. Direction = S.E. to W. (?).			Kastner's Archiv, S. 326.
— — 17.	Palermo	A shock		On the 17th, 18th, 21st, and 22nd, there were violent and widely extended storms in various parts of Europe.	Poggendorff's Annalen, B. xxiv. S. 54.
— — 18.	Lunröe in Norway	Another shock			Bull. de la Soc. Géol. t. vii. p. 21.
— — 19.	Palermo	Another shock			Poggendorff's Annalen, B. xxiv. S. 52.
— April 1. 1 A.M.	Venice	Three slight oscillations.			Allgemeine Zeitung, 1827, Nr. 107. S. 408.
— — — Between 11 P.M. and midnight.	Appenzell; and at the same time in the Engadine, at St. Gall, Trente, and Venice.	An earthquake consisting of three oscillations.		Probably the last account refers to the same event as that here recorded, or to the following.	Kastner's Archiv, B. xv. S. 140; Ann. de Chim. et de Phys. t. xxxvi. p. 399.
— — 2. 1^h 20^m A.M.	Bevers in the Upper Engadine.	Two successive shocks. This was the twentieth time that earthquake shocks had been felt at this place during the winter.			Ditto; Hamburg Corresp. 1827, Nr. 74; Phil. Mag, N. S. vol. iii. p. 463.
— — 11.	The islands of Ponza and Ischia, off the coast of Naples.	Violent vibratory shocks. The direction was from Ponza to Ischia.			Froriep's Notizen, Nr. 496 (B. xxiii. No. 12), quoting Covelli.

11h 51m A.M.	the Church.	Rather severe undulations.			Ann. de Chim. et de Phys. t. xxxiii. p. 408.
—— —— 17.	Venice	A slight vibratory shock.			Hamb. Corresp. 1827, No. 77.
—— —— 18. 2h 20m P.M.	Trieste	Two shocks, lasting some seconds. Direction = N. to S.		More strongly felt in the houses on the sea-shore than in those more inland.	Gothaische Zeitung, 1827, Nr. 73.
—— —— 25.	Lunröe in Norway	Another shock			Bull. de la Soc. Géol. t. vii. p. 21.
—— May 2. 0h 49m A.M.	Trente in the Tyrol	A severe shock			Férussac, Bull. des Sc. Nat. t. xviii. p. 195.
—— —— 11.	Lunröe in Norway	Another shock			Bull. de la Soc. Géol. t. vii. p. 21.
—— —— 13.	Ditto	Ditto			Ditto.
—— —— 17.	Ditto	Ditto			Ditto.
—— —— 18.	Ditto	Five shocks			Ditto.
—— —— 27.	Ditto	Another slight shock.			Ditto.
—— —— 28.	Ditto	Ditto			Ditto.
—— —— 29.	Ditto	Ditto			Ditto.
—— —— —	Vajaca in Mexico	Two slight shocks			Phil. Mag. N. S. vol. iii. p. 463; Constitutionnel, 6 Oct.; Ann. de Chim. et de Phys. t. xxxvi. p. 398 et t. xlii. p. 407.
—— —— 30. 7h 32m A.M.	Lima in Peru	Violent shocks		The walls of the principal buildings were thrown down. Incalculable damage was done in the city.	Ann. de Chim. et Phys. t. xxxix. p. 406, t. xlii. p. 407.
—— —— —	Santiago in Chili	A rather slight earthquake.		Probably the same with the Peruvian earthquake.	Garnier, Météorologie, p. 152.
—— June 2.	Lunröe in Norway	Three shocks			Bull. de la Soc. Géol. t. vii. p. 21.
—— —— 3. 2 A.M.	In the Island of Martinique.	A slight vibratory shock.		At the same time the first rain fell after *sixty-six days'* drought; no such instance of dry weather *in the West Indies was remembered.*	Phil. Mag. N. S. vol. iii. p. 463; Hertha, B. x. S. 105, B. xii. S. 182.
—— —— —	Lunröe in Norway	Two more shocks			Bull. de la Soc. Géol. t. vii. p. 21.
—— —— 4.	Ditto	Another shock			Ditto.
—— —— 5.	Ditto	Ditto			Ditto.
—— —— 6.	Ditto	Ditto			Ditto.
—— —— 12. 11 A.M.	Palermo	Several shocks, which lasted with short intervals for 18 minutes. The motion was constantly oscillatory.			Ann. de Chim. et de Phys. t. xxxvi. p. 399; Férussac, Bull. des Sc. Nat. t. xviii. p. 196.

1.	2.	3.	4.	5.	6.
1827. June 12. $1^h 30^m$ (A.M. or P.M.?).	Tehuacan in Mexico ...	A violent shock	....	Accompanied by terrible noise. Many buildings were injured.	Phil. Mag. N. S. vol. iii. p. 463; Constitutionnel, 6 Oct.
—— —— 16. 5^h or $5^h 30^m$ A.M.	Aquila in the kingdom of Naples.	A slight shock........	....	....	Phil. Mag. N. S. vol. iii. p. 463.
—— —— 21. 11 A.M.	Palermo	Four severe shocks in seven seconds. The motion was oscillatory, and from W. to E.	....	No damage done........................	Ditto; Poggendorff's Annalen, B. xxiv. S. 54.
—— —— 29.	Ditto	Another shock	....	....	Poggendorff's Annalen, B. xxiv. S. 54.
—— —— or July.	The town of Tokat in the government of Sivas, Asia Minor.	An earthquake	....	A large part of the town was destroyed. The damage done extended also to the surrounding country.	Gothaische Zeitung, 1827, Nr. 134; Kastner's Archiv, B. xiv. S. 216; Constitutionnel, 25 Août.
—— July 5.	Palermo	Another shock	....	....	Poggendorff's Annalen, B. xxiv. S. 54.
—— —— ——	Santiago in Chili.........	A slight shock........	....	....	Ann. de Chim. et de Phys. t. xlii. p. 407.
—— —— 7.	Lunröe in Norway	Three shocks	....	....	Bull. de la Soc. Géol. t. vii. p. 21.
—— —— 8.	Ditto	Another shock	....	....	Ditto.
—— —— 11.	Ditto	Ditto	....	July 11–13, violent storms at Stockholm, and over the Baltic to St. Petersburg. v. Hoff.	Ditto.
—— —— 21. $5^h 45^m$ P.M.	Island of Martinique ...	A violent shock	....	M. Perrey gives the date July 24	Hertha, B. xii. S. 182.
—— Aug. 5. $10^h 30^m$ A.M.	Ditto	Two more severe shocks.	....	....	Monthly Magazine, April 1828, p. 429; Revue Encycl. Fév. 1828.
—— —— 6. 10 P.M.	New Albany, on the Ohio, in Floyd county, Indiana.	A slight shock........	....	....	Columbus, Nov. 1827, S. 145.
—— —— 7. 1 A.M.	Ditto	Another shock, more severe than the last. The quick agitation of the earth, like ebullition, lasted more than a minute.	....	A forge was thrown down, but otherwise no damage was done. This is said to have been the second earthquake of the year, but the date of the first is not given.	Ditto.
—— —— 8.	Petropaulowsk in Kamtschatka.	On this and the two following days se-	....	Loud explosions were heard. These shocks were attendant on an eruption of Awatschinskaja.	Mém. de l'Acad. de St. Petersburg, 1833, 2. pp. 11. 28; Leonhard's

		veral violent shocks were felt, especially one on the morning of the 9th.			Zeitschrift, 1829, B. ii. S. 557.
1827. Aug. 14. 2 P.M.	Palermo	Several oscillatory shocks, which succeeded each other at very short intervals for about eighteen minutes.			Phil. Mag. N. S. vol. iii. p. 463; Poggendorff's Annalen, B. xxiv. S. 54.
—— —— 23. 10 P.M.	New London in Connecticut, United States.	An earthquake		Accompanied by a noise like the rolling of a heavy waggon, the noise increasing for three or four seconds, and then decreasing for an equal time.	Columbus, Dec. 1827, S. 197.
—— Sept. 18.	Lisbon	A slight shock			Journ. des Débats, 8 Oct.; Ann. de Chim. et de Phys. t. xxxvi. p. 398.
—— —— 25. 5h 30m A.M.	Island of Martinique	Another shock			Revue Encycl. 1828, Fév.; Hertha, B. xii. S. 182.
—— —— ——	Lunröe in Norway	Two more shocks			Bull. de la Soc. Géol, t. vii. p. 21.
—— —— 26.	Ditto	Ditto			Ditto.
—— —— Some day of this month *before* the 26th.	Fort Kolitaran near Lahore, Hindostan.			The fort was destroyed, and about a thousand persons perished beneath the ruins. A hill was shaken down, which falling into the river Rowée, produced an inundation of a hundred Coss of land.	Madras Gazette, 26 Sept. 1827.
—— Oct. 2. 4 P.M.	Island of Martinique	Another shock			Revue Encycl. 1828, Fév.; Hertha, B. xii. S. 182.
—— —— 10. 2h 48m P.M.	At Zürich, and all along the shore of the lake.	A rather severe shock			Constitutionnel, 21 Oct.; Ann. de Chim. et de Phys. t. xxxvi. p. 398.
—— —— 11. 8 P.M.	Ismail, Tutschkow, and Kischenew, in Bessarabia.	Two slight shocks with a very short interval.			Allgemeine Zeitung, 1827, Nr. 327. S. 1308.
—— —— 14. or 15. 8h 35m P.M.	Jassy in Moldavia	Two rather violent shocks, with an interval of but a few seconds. The motion was horizontal, from N. to S.		Accompanied by subterranean noise. No damage done. The air had been very warm for several days. On the 14th at noon the thermometer stood at 24°·1 R. in the shade. The Allgemeine Zeitung gives the date October 14, while the other authorities quoted give the 15th as the day.	Allgemeine Zeitung, 1827, Nr. 303. S. 1212; Phil. Mag. N. S. vol. iii. p. 463; Ann. de Chim. et de Phys. t. xxxvi. p. 398.

1.	2.	3.	4.	5.	6.
1827. Oct. 20. Noon.	Tiflis in Georgia. Also at Stavropol in the Caucasus.	A severe shock. Including the accompanying noise, the phænomenon lasted more than forty minutes (?). Direction = S.E. to N.W. At Stavropol 4 shocks were felt, the first being the most severe. At Tiflis six more shocks were felt before the 23rd, and others at frequent intervals up to the 1st of February following.		Accompanied by a dull noise. The weather was calm, and the temperature +17° R. Some walls were cracked by one of the subsequent shocks. This earthquake was probably also felt, though slightly, at Erivan.	Ann. de Chim. et de Phys. t. xxxix. p. 406; Férussac, Bull. des Sc. Nat. t. xiv. p. 44; Journ. des Débats, 9 Déc.; Moniteur, 10 Déc.
—— —— 21.	Lunröe in Norway	Another shock			Bull. de la Soc. Géol. t. vii. p. 21.
—— —— 23.	Ditto	Ditto			Ditto.
—— —— 25.	Ditto	Ditto			Ditto.
—— —— 30. $5^h\ 30^m$ A.M.	In the Cantons of Tavaro, Talano, and Sartene in Corsica.	Two shocks			Constitutionnel, 27 Nov.; Ann. de Chim. et de Phys. t. xxxvi. p. 398.
—— Nov. 16. About 6 P.M.	In Columbia, S. America, on a line from N.E. to S.W., from S^{ta} Fé-di-Bogota to Pasto, and thus parallel to the chain of the Andes. Whether felt to the east of the Andes or not, is not to be learned from the accounts.	A violent and widely-extended earthquake. The first shock came very suddenly, and was followed by an undulatory movement of the ground, lasting forty or fifty seconds, after which there came again a short violent shock. In Popayan the undulatory motion lasted three or four minutes, the direc-		This earthquake was more destructive than the more violent one of 1826, from its duration and the character of the motion. In Bogota, Neyva, Popayan, Parace, and in fact all the towns and villages shaken, the damage was terrible, the houses crumbling into ruins everywhere. The destruction was greatly increased by the overflowing of several of the rivers, as the Magdalena, Cauca, &c., partly caused by heavy rain at this time, and partly by the falling in of banks and the hills overhanging the rivers. Great clefts opened in the ground in some places, into one of which the river Tunza flowed. Violent detonations followed the shock, occurring at intervals of thirty seconds with wonderful regularity. From some of the	Moniteur, 1828, No. 44. p. 71, No. 71. p. 293; Férussac, Bull. des Sc. Nat. t. xvii. p. 356; Ann. de Chim. et de Phys. t. xxxix. p. 406, t. lii.; Phil. Mag. N. S. vol. iv. p. 56; Allgemeine Zeitung, 1828, Nr. 58. S. 229, quoting the Journal of Bogota, El Constitutionel.

		tion being S.E. to N.W. At this place the earth seemed much disturbed during the whole of the 16th and following night, and shocks of more or less severity were felt every forty or fifty minutes, up to 5 A.M. on the 17th.		clefts quantities of gas were discharged, by which rats and serpents were found to be asphyxiated; and the Magdalena and Cauca for hours bore along masses of mud with them, smelling strongly of sulphuretted hydrogen.	
1827. Nov. 17. 9 A.M. (6 P.M. of the 16th, at Sta Fé-di-Bogota, would correspond to 8h 40m A.M. on the 17th at Ochozk).	Ochozk on the eastern coast of Siberia.	Severe shocks, lasting five to seven minutes.	....	This account is rendered very remarkable by its showing the earthquake in Siberia to have been almost exactly at the same time as that in S. America, and therefore making it probable that the same shock was propagated to the enormous distance between Sta Fé and Ochozk.	Bremer Zeitung, 1828, Feb.
—— —— — 5 A.M.	At Popayan, in the same district of Columbia, shaken on the 16th.	A shock of still greater severity than that felt at this place the evening before, followed by an oscillation or shaking motion of considerable duration.	....	....	Authorities quoted above for the 16th.
—— —— — 11h 45m A.M.	Ditto	The shocks again became very violent.	....	A great part of the town was ruined..............	Ditto.
—— —— — 5 P.M.	Ditto	Another shock........	....	....	Ditto
—— —— 18. 4h 30m A.M.	Ditto	According to some accounts this was the last shock here felt, according to others the motion of the earth continued up to the 21st.	....	On the 21st an eruption of the volcano of Parace began. Thick clouds of vapour are said to have been seen before and on the day of the earthquake, on the old volcano of Tocaima and on the mountains of Santa Anna in Marequito and Parama de Ruiz.	Ditto.

1.	2.	3.	4.	5.	6.
1827. Nov. 21. 8 A.M.	In the valley of Lauterbrunn, Canton of Berne.	A severe earthquake.			Kastner's Archiv, B. xiv. S. 234.
—— —— 22.	Lunröe in Norway	Another shock			Bull. de la Soc. Géol. t. vii. p. 21.
—— —— 24.	Ditto	Ditto			Ditto.
—— —— 29.	Ditto	Ditto			Ditto.
—— —— 30. 3 A.M.	Islands of Martinique, Guadeloupe, Marie Galante, Antigua, and St. Domingo. Also said to have been felt in Terra Firma, South America.	A violent shock of thirty or forty seconds' duration. Direction E. to W., or according to others, S. to N. In Martinique it was vertical, and the most severe shock there remembered. This is said to have been the tenth earthquake in the West Indies within six months.	Also felt at sea, 100 leagues to the W. of Martinique, on board the ship 'Le Martiniquois,' in a place where shoals are marked on the charts. All the vessels near Pointe à Petre, and in the roadsteads of St. Pierre and Port Royal, also experienced the shock.	Preceded in some places, as in Guadeloupe, by a violent squall of wind. In Martinique buildings were thrown down.	Moniteur, 1828, Nr. 13. p. 51, No. 43. p. 169, No. 57. p. 238; Ann. de Chim. et de Phys. t. xxxvi. p. 398; Phil. Mag. N.S. vol. iii. p. 463; Hertha, B. xii. S. 183.
—— Dec. 1. 10 A.M.	Island of Martinique	Another shock, accompanied by undulatory motion.			Hertha, B. xii. S. 183, quoting Revue Encycl.
—— —— —— 5^h 15^m P.M.	Ditto	Ditto			Ditto.
—— —— 3.	In Sweden	Shocks			Kastner's Archiv, B. xiv. S. 234.
—— —— 8. 5^h 20^m A.M.	Island of Martinique	Another shock, accompanied as before on December 1, by undulatory motion.		Immediately followed, as had been some of the other shocks of the few days preceding, by rain. On the 9th a remarkable volcanic eruption, accompanied by shocks of considerable violence but small extent, took place near the village of Jokmali in the province of Bakon on the Caspian Sea. Vide v. Hoff.	Hertha, B. xii. S. 183, quoting Revue Encycl.
—— —— 13. 2^h, 3^h 30^m, and 4^h A.M.	Lisbon	The shocks were from W. to E. The one at 3^h 30^m was followed, six seconds later, by two more		Accompanied by a dull noise. Church bells were made to toll, and the walls of the houses cracked. Dogs howled before the shocks. In the afternoon of the same day an extraordinary noise was heard on the lake of Salungen in	Moniteur, 13 Fév. 1828; Férussac, Bull. des Sc. Nat. t. xviii. p. 342; Poggendorff's Annalen, B. xix. S. 460.

		vibrations.		Saxony. A similar phenomenon had been there remarked on the 1st of November, 1755, the day of the great earthquake of Lisbon.	
1827. Dec. Night between 21 and 22. (Probably at 2 and 3 A.M. on the 22nd.)	Friburg, Berne, &c. on the Upper Rhine.	v. Hoff, quoting Kastner's Archiv, mentions two shocks from W. to E. at the hours given in Col. 1, but does not say where they were felt. The account probably refers to the places here given.	....	....	Communication of M. Studer to M. Perrey; Kastner's Archiv, B. xiv. S. 234.
—— (Four years after the eruption of Austur-Jökull in 1823.)	In the neighbourhood of the volcano Austur-Jökull in Iceland.	An earthquake	....	....	Voyage en Islande,' partie Géol. p. 214.
1828. Jan. 3. After noon.	Aquila in the Abruzzo, kingdom of Naples.	Two shocks from S.E. to N.W.	....	....	Kastner's Archiv, B. xiv. S. 236.
—— —— —	Lunröe in Norway	Another shock........	....	....	Keilhau.
—— —— 12.	Near Hohen-Memmingen, about half a mile E.N.E. from Giengen, in Swabia.	A slight vibratory shock from N.W. to S.E.	....	The weather was unsettled. The thermometer stood before noon at +5°, after noon at +6°·7 R. During the following night a violent storm raged in the Channel and on the S. and E. coasts of England, felt later at Nuremberg and in Thuringia.	Schweigger's Jahrb. t. xxix. (lix.) S.34; Correspondenzblatt d. Würtemb. Landwirths. Vereins. Sept. 1829. S. 170.
—— —— 14. 11h 45m P.M.	Venice	Slight undulatory shock from S. to N.E. (?), lasting 2 seconds.	....	After the motion had ceased a prolonged dull noise was heard in the air. The weather was dark and stormy. Walls were cracked.	Kastner's Archiv, B. xiii. S. 71; Ann. de Chim. et de Phys. t. xxxix. p. 408; Journ. des Débats, 26 Janv.
—— —— 16.	Gross Kostely in the county of Krassova, Hungary.	An earthquake	....	Preceded by a severe thunderstorm, lasting an hour and a half.	Leonhard's Zeitschrift, 1828, S. 651.
—— —— 29. 10h 15m A.M.	Ohnastetten in the bailiwick of Urach, 2700 feet above the level of the sea, and Unterhausen in the adjoining valley of Honau,	A pretty smart shock from W. to E., lasting about 2 secs.	....	Accompanied by a heavy subterranean noise, like a distant cannonade. Windows rattled, unfastened sashes swung to, articles of furniture were moved from their places, &c. The barometer at Ohnastetten fell about 3 lines soon after the shock. At Tübingen it was 4 lines	Schweigger's Jahrb. t. xxix. (liv.) S.34; Corresp. d. Würtemb. Landwirths. Vereins. Sept. 1829. S. 170, 171.

1.	2.	3.	4.	5.	6.
	near Tübingen, Swabia			above the mean height, and fell 2 lines before the following morning, the weather remaining calm and clear.	
1828. Feb. 2. 10h 15m A.M.	Island of Ischia off the coast of Naples. The earthquake was not felt on the adjacent coasts or islands.	One of the most violent of modern earthquakes, though confined to but a limited district. Slight movements had been felt at 3 A.M. at Forli, Faenza, and Imola, in the States of the Church, and at Foggio, San Severo, Barletta Bani, and some other places in the kingdom of Naples. In the last-named place the motion was from E. to W., and began about 7 A.M. The earthquake in Ischia consisted of an undulatory shaking motion, lasting 4 secs.	The sea was quite calm, and remained so all day.	Preceded by no remarkable phænomenon, except that in the morning Vesuvius sent forth smoke, and afterwards flame and stones. The springs exhibited no change, except that of Rita, the temperature of which was slightly altered. Immediately before the shock, in the space of 3 secs., three loud explosions were heard, which appeared to come from beneath upwards, or from the interior of the Epomeo outwards. These explosions were very remarkable along the coasts of Casamicciola, Lacco, and Forio; but in the interior of the island, where the shock was most severe, they were scarcely remarked. The part of the island which suffered most lies west of Casamicciola, between Fango and Casamenello, the shock apparently passing from the Epomeo thither. In Casamicciola a part of the buildings fell together to the ground, and twenty-eight men were killed and many injured. In Serrafontana, Forio, and Testaccio no damage was done, but Lacco suffered remarkably. The barometer had been higher in the middle of January than for six years before.	Allgemeine Zeitung, 1828, Nr. 61. S. 243; Covelli in the Journal Il Pontano, Nr. 2; Biblioth. Univers. Oct. 1828, p. 157; Kastner's Archiv, B. xiv. S. 327.
—— —— 4.	Tabasco, about 200 miles E.S.E. of Vera Cruz, Mexico.	A violent earthquake.	....	The roofs of the churches and the prison were destroyed, and the bank of the river Tabasco sank 30 feet. Villa Hormosa, a town 7 miles higher up the river, was almost entirely reduced to a heap of ruins.	Columbus by Röding, B. ii. S. 140.
—— —— 6.	Lunröe in Norway	Another shock	....	....	Keilhau.
—— —— 8. 2h 30m P.M.	Again in the district of the Swabian Alps, shaken on the 29th January, but over a greater extent, including Urach, Mün-	Another shock, of greater violence than that of Jan. 29. It lasted 3 or 4 secs., in the direction S.W. to N.E.	....	During a profound calm. Subterranean noise accompanied the shock. The houses were strongly shaken, tables, chairs, &c. were thrown about, and in some villages chimnies fell. Men who were in the forest at the time held fast by the trees, and fancied that the	Schweigger's Jahrb. t. xxix. (lix.) S. 35; Corresp. d. Würtemb. Landwirths. Vereins. Sept. 1829, S. 171, 172.

	singen, Reutlingen, S.W. to Tuttlingen, N.W. to Tübingen, and most severely in Kohlstetten, Gross- and Klein-Engstingen, Hobzelfingen, and Ohnastten on the mountains.			earth was sinking under them. In Tübingen the motion was very distinctly felt in many parts of the town. The barometer at that place stood at about the mean height, and fell on the day of the earthquake and the following 3 lines, but no storm or rain ensued. Herr Schübler remarks, that both this shock and that of the 29th January proceeded from the same chain of mountains, which in this district is often intersected by basaltic formations.	
1828. Feb. 13.	Lunröe in Norway	Another shock			Keilhau.
—— —— 14.	Island of Ischia	Another severe shock.		Some buildings on the plains of Casamicciola were ruined.	Authorities quoted under Feb. 2.
—— —— A short time before the 16th.	Manilla in Luçon, Philippine Isles.	Several slight shocks.		The eruption of the volcano of Albay, which began in June 1827, still continued.	Der Freimüthige, 1829, Nr. 54. S. 216.
—— —— 23. About 8^h 20^m A.M.	In Belgium, the north of France, and the basins of the Meuse, Rhine, and Moselle. According to v. Hoff, the limits of this earthquake were, to the S., Longuyon and Commercy; to the S.W. and W., Avesnes, Le Quesnay, Dunkirk, and Bruges; to the N.W., Middelburg and Flushing; to the N., Dordrecht and Upbergen; to the E., as far as the Rhine, and even beyond it. The district most violently disturbed lies between Ath and Maestricht, and Namur and Louvain.	An earthquake, more remarkable for the extent of the district shaken than for its intensity. At Liège several shocks were felt, at first very slight, but afterwards rather severe, lasting 7 to 8 secs., apparently in the direction S.E. to N.W. Here and at Maestricht slight motion was said to have been felt about 2 A.M. At Tirlemont the shocks lasted 7 minutes (seconds?). At Commercy there were two shocks from S. to N. At Longuyon but one, rather severe, and lasting more than a		At Liège the weather was quite calm. The shocks there felt were accompanied by a dull noise. The houses shook, and articles of furniture exhibited a very marked oscillatory motion. Some chimnies were thrown down. The motion was most felt in the upper stories of the houses. It was also felt in the coal-pits, in one of which a rolling noise was said to have been heard. The barometer remained as before the shocks, at 27 inches 1 line. At Maestricht, Tirlemont, Dunkirk, &c. chimnies were thrown down, walls cracked, glass and china broken, and furniture moved about. Some magnetic perturbations are said to have preceded or accompanied the earthquake. Thus at Cologne, on the 23rd, a variation of four degrees to the west was observed. On the 21st the barometer was unusually low at Geneva, Coburg, and other places; and on the 19th, 20th, 21st, 22nd, and 23rd, terrible storms raged over the centre of Europe. The earthquake was felt at almost all the places included within the limits given in column 1, as Mons, Namur, Louvain, Aix-la-Chapelle, Hainaut, Dusseldorf, Cologne, Bonn, Rema-	Journ. des Débats, 1 et 28 Mars; Constitutionnel of same dates; Moniteur, 27 et 28 Fév., 1 et 28 Mars; Ann. de Chim. et de Phys. t. xxxix. p. 408; Férussac, Bull. des Sc. Nat. Mars 1829, Mai 1830; Allgemeine Zeitung, 1828, Nr. 65. S. 260; Phil. Mag. N. S. vol. iv. p. 55; Kastner's Archiv, B. xiii. S. 384; Hertha, 1828, Sept. 12. iii. 78; Poggendorff's Annalen, B. xii. (lxxxviii.) S. 331, xiii. (lxxxix.) S. 153; Schweigger's Jahrbuch, B. xxiii. (liii.) S. 1.

1.	2.	3.	4.	5.	6.
		minute. At Avesnes the shock was from E. to W., equally strong, but of shorter duration. At Dunkirk the direction of the motion was variously reported; it was most generally given as S. to N. At Brussels the shock was exceedingly slight, though situated near the centre of the disturbed district.		gen, Coblentz, &c. &c. For a long account of this earthquake vide v. Hoff's 'Chronik.'	
1828. Feb. 24.	Washington and Baltimore in the United States.	A violent shock		v. Hoff remarks that, although the hour at which this shock was felt is not given, if the day be correctly recorded the present shock cannot have been simultaneous with that in Belgium.	Hertha, B. xii. S. 100.
—— —— 26. 8 A.M.	Upbergen and Beck near Nimeguen, in the Netherlands.	A slight shock from S. to N., lasting 2 secs.		In all probability this is but an account of the shock of the 23rd, mistaken as to day. Nöggerath believes this to be the case.	Arnheimer Zeitung, 27 Feb.
—— Mar. 1.	Lunröe in Norway	Another shock			Keilhau.
—— —— 3.	Ditto	Ditto, severe			Ditto.
—— —— 4.	Ditto	Two shocks			Ditto.
—— —— 5.	Ditto	Some other very feeble shocks.			Ditto.
—— —— 6. 2h 30m A.M.	In the West Indies (which island or islands?).	A slight shock from E. to W.			Ann. de Chim. et de Phys. t. xxxix. p. 410.
—— —— 9. Between 10 and 11 P.M.	Washington and some of the neighbouring towns.	Two severe shocks, lasting together not quite 30 secs. The first was stronger than the second.		Accompanied by a noise like the rolling of heavy waggons over pavement. People were wakened by the shocks and sprang out of bed.	Monthly Magazine, 1828, August, p. 202; Ann. de Chim. et de Phys. t. xxxix. p. 410.
—— —— 12.	In Calabria	An undulatory shock, lasting 5 secs.			Allgemeine Zeitung, 1828, Nr. 106. Bell; Ann. de Chim. et de Phys. t. xxxix. p. 410.

1828. Mar. 13.	Ditto	Five more shocks ...	....	Some trifling damage was done at Palmi	Ditto.
— — 14, and following days.	Vesuvius and the surrounding country.	Many shocks	....	Accompanying a violent eruption which began on the 14th and continued up to the 26th.	Bibl. Univ. Mai 1831, pp. 73–89; Hertha, B. xii. S. 89; Ann. de Chim. et de Phys. t. xxxix. S. 424, &c.
— — 22. 0h 20 or 30m A.M.	Jauche, Jandrin, Jandrenouville, and more slightly at Louvain, in Belgium.	A shock of 3 seconds' duration.	....	*Possibly* nothing more than an account of the event of Feb. 23, wrongly given as to date.	Schweigger's Jahrbuch, xxiii. (liii.) S. 45.
— — — About 2 A.M.	On the Dürrenberg, near Strehla on the Elbe, and the neighbourhood.	A remarkable shock ..	....	Accompanied by rolling noise. The evening before, a warm wind blew from the south, with thunder-clouds and heavy rain. At the time of the shock there was a storm, and though thunder-clouds were to be seen in the north, in the zenith the sky was clear. On the 21st a large landslip took place on Mont Cerisier, near Audenaarden in Belgium, by some considered as a consequence of the late earthquake in that country. Moniteur, 1828, no. 93. p. 394; Schweigger's Jahrbuch, B. xxiii. (liii.) S. 49.	Ditto, quoting Berliner Vossischen Zeit. Mitth. d. Statist. Vereinsina Königreich Sachsen. Lief. xi. p. 42.
— — 23. About 9h 30m A.M.	Le Quesnoy and Jauche in Belgium.	A severe shock, from beneath upwards.	....	Unaccompanied by noise. *Possibly* but the same with the event of Feb. 23, wrongly reported as to date.	Moniteur et Constitutionnel, 27 et 28 Mars; Ann. de Chim. et de Phys. t. xxxix. p. 410.
— — 29. 4h 30m A.M.	Island of Martinique ...	A prolonged vibration from E. to W.	....	....	Morgenblatt, 1828, Nr. 253. S. 1012.
— — 30. 7h 32m A.M., at Lima, at Callao a few moments later.	In Peru. Extended but a short distance south of Lima and Callao. It was felt at Arequipa, but not at all at Arica. To the north, however, it was perceived at Surras, Huanaco, and even Truxillo.	A very violent earthquake, probably passing from the chain of the Andes out to sea. In Lima the shocks lasted according to some 29, according to others 40 seconds. In Callao they recurred during 3 min. At 49 min. after midnight another shock, but of short duration, oc-	Some of the phænomena observed on board a ship in the harbour of Callao were very remarkable. On board the 'Volant,' about half-past seven, a noise like distant thunder was heard, and then came a shock, compared to jolting over a rough road in an ill-constructed cart, or to	Great damage was done. Scarcely a house in Lima or Callao remained uninjured, and walls of 6 and even 9 feet thick were thrown down. The cloud of dust which arose from the ruined buildings of Lima was seen at Callao *before* the shock itself was felt there. At Surras streams of water burst forth from the earth. At Truxillo and elsewhere in the northern part of the district shaken, the most extraordinary and violent rain followed, lasted four days, and produced most disastrous inundations. On board the ship 'Volant' the shock is said to have been felt *before* it was perceived on shore, while the accounts from other vessels agree in saying that the earthquake was first felt on the land.	Moniteur, 1828, no. 254. p. 1435; Galignani's Messenger, 30 Aug.; Allgemeine Zeitung, 1828, Nrs. 224, 237 u. 250; Ann. de Chim. et de Phys. t. xlii. p. 416, quoting the Globe; Morgenblatt, 1829, Nr. 238; Férussac, Bull. des Sc. Nat. t. xvii. p. 354.

1.	2.	3.	4.	5.	6.
		curred; and during the six following days others were felt.	the vessel striking upon rocks or sandbanks. The water, which was 25 fathoms deep, hissed and boiled as if red-hot iron had been thrown into it, and the surface was covered with bubbles of gas of a sulphurous odour, and quantities of dead fish. The sea had been quite clear, but was now disturbed and muddy. The ship swung to the extent of 14 in. on either side. On weighing anchor, the chain cable of one of the anchors was found to be half melted in a considerable part of its length, the links being drawn out also lengthways. The chain of the second anchor was quite uninjured, as were those of all the other ships in the bay.		
1828. April 4. 5 P.M.	Santiago in Chili	A severe vibratory shock.			Ann. de Chim. et de Phys. t. xlii. p. 407.
—— —— From 6 to 10.	Forli in the States of the Church, and more se-	Eighteen shocks at Forli during these			Constitutionnel, 29 Avril; Ann. de Chim. et de Phys. t. xxxix. p. 410;

	verely at Meldola and Galeata. Also felt at Ancona, Pesaro, and Sinigaglia.	four days.			Férussac, Bull. des Sc. Nat. t. xviii. pp. 196 et 342; Schweigger's Jahrb. B. xxiii. (liii.) S. 52 u. 53; Allgem. Zeitung, 1828, Beil, 112. S. 447.
1828. April. Night between 10 and 11.	Rome	A slight undulatory shock. It was very severe at Pesaro.			Ditto.
——— 11. At Florence, 11h 20m P.M.; at Venice, 11h 22m; at Zara, 11h 30m.	Florence, Bologna, Venice, Zara, and Trieste.	At Florence an undulatory shock, lasting 20 or 22 secs. The motion was at first from E. to W., then from S. to N., and then again from E. to W. At Venice a second shock was felt somewhat later. At Zara also there were two shocks, of which the second was the most violent.		At Florence the sky was clear; the western horizon alone was covered with a slight mist. At Zara loud subterranean noises were heard. At Venice, about 3 A.M. in the same night, a violent thunder-storm burst forth.	Ditto.
——— Night between 12 and 13.	Berlin	Shocks		"This account is at least doubtful."—Poggendorff.	Schweigger's Jahrbuch, B. xxiii. (liii.) S. 53.
—— May 10. 6h 15m A.M.	Santiago in Chili	A severe vibratory shock.			Ann. de Chim. et de Phys. t. xlii. p. 407.
——— 13. 10h 30m A.M.	Büren and Limbach, in the canton of Berne, Switzerland.	Severe shocks		The Constitutionnel of the 28th May gives the hour as half an hour after midnight.	Ditto, t. xxxix. p. 411.; Mérian.
——— 20.	In the south of Scotland, felt near Dumfries.	An earthquake		Felt in the mines of Wanlock-head	D. Milne's Catalogue of British Earthquakes, *loc. cit.*
——— 21. 8 P.M.	Santiago in Chili	A slight vibratory shock.			Ann. de Chim. et de Phys. t. xlii. p. 407.
——— 22. Midnight.	Soleure in Switzerland				P. Mérian.
——— 23. 3 P.M.	Santiago in Chili	Another slight vibration.			Ann. de Chim. et de Phys. t. xlii. p. 407.
—— June 15. 5 A.M.	Smyrna	Two shocks, with scarcely any interval; of which t e		Many houses were injured	Ditto, t. xxxix. p. 411; Constitutionnel, 8 Août.

1.	2.	3.	4.	5.	6.
		first was vertical, and lasted 2 secs., the second horizontal, from N. to S.			
1828. June 15.	Marsala in Sicily	An undulatory shock.		About the end of the month there was an eruption of gas or vapour in the island of Ischia.	Bibl. Univ. Mai 1831, p. 85.
—— —— Night between 17 and 18.	Poitiers in the departm. Vienne.	A slight shock			Journ. des Débats, 27 Juin; Ann. de Chim. et de Phys. t. xxxix. p. 411.
—— July 4. $10^h\ 30^m$ P.M.	Santiago in Chili	A severe shock			Ann. de Chim. et de Phys. t. xlii. p. 407.
—— —— 6. $2^h\ 30^m$ A.M.	Island of Martinique				Froriep's Notizen, B. xxii. Nr. 7. (469.) S. 106.
—— —— 20. 1 P.M.	Bhud in the East Indies (in Hindostan?).	A violent shock from E. to W.		Water was thrown out of glasses which were half-full. The sky was clouded, and in the afternoon it rained heavily.	Ann. des Voyages, 1829, Mai, p. 248, quoting the Asiatic Journ.; Leonhard u. Bronn, N. Jahrbuch, 1833, S. 125.
—— —— 21.	Alt-Schamachi in the Caucasus, 80 or 90 wersts from Baka, at which place the shocks were not felt.	An earthquake. Five shocks were felt in three days.			Authorities quoted below for this place, under August.
—— —— 26.	Coire in the Grisons, Switzerland.				Communication of M. Studer to M. Perrey.
—— —— 29. $4^h\ 3^m$ A.M.	Island of Martinique			Froriep's 'Notizen,' here quoted, mentions a *disastrous* earthquake at Lima on the 30th July, but doubtless it refers to the 30th March.	Froriep's Notizen, B. xxii. Nr. 7. (469.) S. 106.
—— Aug. 6. Began after midnight (of the 5th?).	Schouscha in Georgia	Several shocks, continuing until morning. Three more shocks were felt during the day, and two others before 1 o'clock the following night.		Preceded by continuous rain and violent wind	Journ. des Débats, 15 et 21 Oct.; Moniteur, 30 Oct.; Férussac, Bull. des Sc. Nat. t. xvii. p. 352, t. xxvi. p. 31; Ann. de Chim. et de Phys. t. xxxix. p. 411, t. xlii. p. 417; Galignani's Messenger, Oct. 22; Allgemeine Zeitung.
—— —— Night between 7 and 8.	Kouba, in the same district of the Caucasus.	Two rather severe shocks, followed by a slighter one about 3 A.M.			Ditto.

1828. Aug. 9. 7 P.M. to midnight.	Schouscha again. This earthquake is said to have extended throughout all the provinces of the Ottoman empire.	Twelve more shocks.		This earthquake in the Caucasus seems to have been of great violence, but whether most damage was done in July or August is not clear. In Alt-Schamachi and the surrounding villages great numbers of buildings were utterly ruined, and others more or less injured. The village of Mongalou was buried beneath a great landslip (brought down by the earthquake). Three large springs burst forth where the soil had been torn away from the surface of the mountain. After the earthquake the streams are said to have been more or less swollen. Half of the village of Ischagana was swallowed up by the earth. In several places fissures and new springs made their appearance. At the village of Sahiany a fissure was observed of nearly 3 feet in width and 2½ wersts long. During the night a light appeared above it like lightning.	Ditto.
—— —— 10. $1^h 55^m$ A.M.	Santiago in Chili	Another severe shock.			Ann. de Chim. et de Phys. t. xlii. p. 407.
—— —— 13. Between $1^h 30^m$ and 2 A.M.	In Belgium. Felt at Brussels, but no other places mentioned.	Two slight shocks		Accompanied by remarkable subterranean noise.	Kastner's Archiv, B. xiv. S. 392.
—— —— 14. In the morning.	Santiago in Chili	Another severe vibratory shock.			Ann. de Chim. et de Phys. t. xlii. p. 407.
—— —— — Between noon and 1 P.M.	Again at Schouscha in Georgia.	Two more shocks. Six of those felt at this place were very severe, and lasted a minute each.		Some walls were thrown down at this place	Ditto, t. xxxix. p. 411, and other authorities quoted above.
—— —— 20.	St. Paul de la Valtrie in Canada.	A shock		Accompanied by subterranean noise	Corresp. d. Würtemb. Landw. Vereins. 2 Heft, 1829, S. 115.
—— —— 25. $11^h 40^m$ P.M.	Santiago in Chili	Another severe vibratory shock.			Ann. de Chim. et de Phys. t. xlii. p. 407.
—— Sept. 10.	Palermo	A shock			Poggendorff's Annalen, B. xxiv. S. 54.
—— —— 13.	In the kingdom of Murcia, Spain.	The first shock of the earthquake of the 15th.			Moniteur, 20 Oct.; Journ. des Débats, 5 Oct.; Constitutionnel, 9 Oct.; Férussac, Bull. des Sc. Nat.

1.	2.	3.	4.	5.	6.
					t. xviii. p. 201; Ann. de Chim. et de Phys. t. xxxix. p. 411, t. xlv. p. 396, &c.
1828. Sept. Night between 14 and 15.	Murcia and some other towns in that province, and in Valencia.	A violent shock	....	Some damage was done, especially at Lorca, Orihuela, and Torrevieja.	Ditto.
—— —— 15. 5ʰ 16ᵐ A.M. The most violent shock at 5 P.M.	Ditto. The principal centre of disturbance appeared to be on the coast, and beneath the villages of Torrevieja and Guardamar.	The earthquake took the direction N.W. to S.E. At 6ʰ 15ᵐ it recommenced with less violence, and again recurred at 3ʰ 30ᵐ the following night. The principal shock at 5 P.M. was followed by 300 others within twenty-four hours, and frequent oscillations were experienced still later, which kept the inhabitants in a constant state of alarm up to March 1829. At Torrevieja and Guardamar eleven violent shocks were felt on this day.	....	At Torrevieja, Guardamar, and La Mata many houses were thrown down and others injured. The water in some of the wells overflowed, while in others it disappeared. In some places loud subterranean noises were heard. On the 14th there had been an extraordinary storm in Catalonia, accompanied by hail of most unusual size.	Ditto.
—— —— 18. 7 A.M.	Calcutta	Two severe shocks. The motion was in a vertical direction.	....	Articles of furniture were thrown up into the air. The atmosphere was quite calm, but heavy and thick.	Asiatic Journal; Ann. de Chim. et de Phys. t. xlii. p. 347; Ann. des Voyages, 1829, Mai, p. 247.
—— —— 23. 9ʰ 10ᵐ P.M.	Santiago in Chili	A rather severe shock.	....	....	Ann. de Chim. et de Phys. t. xlii. p. 407.
—— —— 24. 9 A.M.	Casamicciola in the island of Ischia.	A vibration	....	....	Constitutionnel, 26 Oct.
—— —— 29.	Palermo	Another shock	....	....	Poggendorff's Annalen, B. xxiv. S. 54.

1828. Oct. 1. In the morning.	Island of Gran-Canaria, Canary Isles.	A violent earthquake.	Felt on board vessels in harbour as if they had touched the bottom.	Many buildings were greatly injured	Moniteur, 20 Déc.; Ann. de Chim. et de Phys. t. xxxix. p. 411; Férussac, Bull. des Sc. Nat. t. xvii. p. 353.
—— —— 5. 11h 40m A.M.	Cesena in the States of the Church.	A slight shock			Ann. de Chim. et de Phys. t. xxxix. p. 411.
—— —— 8. 10h 44m and 11h 45m P.M. (v. Hoff gives the hours 10h 45m and 11h 25m). At Genoa, about 10 P.M.	Pesaro in the States of the Church. Also slightly at Genoa.	Slight shocks. The same night (?) slight shocks were also felt at Verona, Lucca, Florence, Novi, and Pignerol.			Ditto, p. 412.
—— —— 9. 3h 11m A.M.	Genoa and Turin. Also felt at Port St. Maurice, Alessandria, Voghera, and even at Marseilles. On this day, and probably at the same time, a shock was felt at Urseren on the St. Gothard.	At Genoa and Turin a violent oscillatory shock, lasting at Genoa 20 seconds, at Turin 30. At Genoa another shock about 8h 30m A.M.	In the harbour of Genoa very considerable motion of the sea was produced, so that vessels struck against each other.	In Genoa small bells were set in motion, and clocks stopped. Some buildings were injured by great cracks, and the damage done by the fall of others was very considerable.	Ditto; Constitutionnel, 16, 18 et 19 Oct.; Moniteur et Journ. des Débats, 18 et 20 Oct.; Studer; Férussac, Bull. des Sc. Nat. t. xviii. p. 200, t. xxvi. p. 31; Allgemeine Zeitung, 1828, Nr. 290. S. 1159, Nr. 308. S. 1231.
—— —— 10. About 1h 30m or 2 A.M.	Ditto, at Turin, Vercelli, Asti, Voghera, &c. More strongly felt on the right bank of the river Po than on the left. The limits of the earthquake of these three days were, Marseilles and a curve joining Vercelli, Voghera, and Genoa, being most violently felt between the two last-named places.	Two slight shocks in the space of half an hour.		Several persons said that they had seen a luminous meteor shortly before the shock. The province of Bobbio, and especially the valley of Stalfora near Voghera, suffered most by this earthquake of the 8th, 9th, and 10th. Many villages were ruined in this district. The weather was very mild, and remained unusually so until the end of December.	Ditto.
—— —— 29. 2 A.M.	In the valley of Nepaul, and further south.	A violent shock, followed by eight slighter ones. The		The weather had been changeable for twenty-four hours before the earthquake. Soon after it became fine. At Catmandou and Patna	v. Hoff, quoting no authority.

1.	2.	3.	4.	5.	6.
		first came from beneath upwards; no horizontal motion was then observed, but the succeeding undulations were from S. to N. During the next night some more oscillations.		some buildings were thrown down. The oscillations felt during the following night were accompanied by loud noise.	
1828. Oct. ...	In Murcia and Valencia, in Spain.	Several more shocks in the course of the month.			Authorities quoted above, 13th Sept.
—— Nov. 11. 7 P.M.	San-Severo and Serra-Capriola in the kingdom of Naples.	A slight shock		On the evening of the 17th a new crater opened on Vesuvius.	Férussac, Bull. des Sc. Nat. t. xix. p. 209.
—— —— 16.	In Columbia, S. America.				Huot, Géologie, p. 116.
—— —— 17. 5 A.M.	Island of Martinique ...	Two shocks			Cuvier, Hist. des Sc. Nat. t. v. p. 63.
—— —— 21. $3^h 30^m$ A.M.	In the district of Reiffenberg, near Frankfort on the Maine.	A vibratory shock ...		Accompanied by subterranean rolling noise	Morgenblatt, 1829, Nr. 45. S. 180, quoting an unpublished lecture of Dr. Bögner of Frankfort.
—— —— 25.	The district between Frankfort and Mayence. Not felt to the north of the Taunus Mountains.	Ditto		Perhaps only the same with the preceding or following accounts.	Journ. des Débats, 8 Janv. 1829.
—— —— 26. $8^h 30^m$ P.M.	Sindlingen in Nassau, 6 or 7 (German?) miles N.W. of Frankfort.	Ditto, violent, from E. to W.			Kastner's Archiv, B. xv. S. 244.
—— —— 27. 7 A.M.	Bonn on the Rhine......	Another similar shock, also from E. to W.			Ditto.
—— Dec. 3. $6^h 30^m$ P.M.	Very widely extended. In the eastern parts of Belgium, in Lorraine, and on the Rhine, principally in a line running nearly N. and S., from Metz to Aix-	Very severe at Aix-la-Chapelle and other places mentioned. Very slightly felt at Maestricht and Liége. Here and at Bonn, Remagen,	On this same day a most remarkable recession of the sea from the southern shores of the Baltic was observed, but this phænomenon	At Liége the barometer was very high, and remained so during and after the shock. At Remagen the shocks were accompanied by noise, and at Stavelot and Malmedy very distinct explosions were heard. From the 1st to the 3rd terrible storms prevailed in the Baltic, Mediterranean, and Adriatic.	Journ. des Débats, Moniteur, Constitutionnel, 8, 9 et 23 Déc., 3 Janv. suiv.; Ann. de Chim. et de Phys. t. xxxix. p. 412; Kastner's Archiv, B. xv. S. 243 u. 429.

	la-Chapelle. Most strongly felt at Aix-la-Chapelle, Burtscheid, Malmedy, Spa, and Stavelot. Also perceived at Cologne, and as far as St. Wendel, ten miles N.E. of Metz.	and Dusseldorf two shocks were perceived, lasting at Liége forty or sixty seconds. At Aix-la-Chapelle the two first shocks, which lasted but two seconds, were from S.E. to N.W., and were followed by a third, the most violent which had been felt there for ten years. It was so also at Burtscheid. At Remagen the direction of the first two was N.W. to S.E., the third was vertical. At Stavelot they lasted four or five seconds. At Siegburg and Pützchen near Bonn three shocks were also felt. At Verviers the two shocks were vertical, and only lasted a few seconds.	was probably owing solely to the storm.		
1828. Dec. 9.	Comrie in Perthshire	A shock, said to be the third within three months.		Accompanied by a noise like thunder, which was heard some miles further to the east.	D. Milne's Catalogue, *loc. cit.*; Froriep's Notizen, B. xiii. Nr. 21 (505). S. 828.
— — —	In the island of Luçon, especially at Manilla.	A destructive earthquake. Lasted two minutes at Manilla.			Singapore Chronicle, Jan. 1, 1829; Corresp. d. Wurtemb. Landw. Vereins. 4 Heft. 1829, S. 235.
— — 11.	In Georgia, United States.	A shock			Corresp. d. Wurtemb. Landw. Vereins. 2 Heft. 1829, S. 115.
— — 13. 9h 30m A.M.	Sandgruben at the foot of the Schwendelberg.	A slight shock, followed, at 9h 40m, by		The second shock was accompanied by loud subterranean noise.	Constitutionnel, 8 Janv. 1829; Ann. de Chim. et de Phys. t. xxxix.

1.	2.	3.	4.	5.	6.
	and at Gaggisberg ($1\frac{1}{2}^h$ from Reusschegg, on the way from Berne to Thun).	an extremely severe one.			p. 412.
1828. Dec. 14. Noon and 2 P.M.	Ditto	Two more shocks			Ditto.
—— —— 16. $2^h\ 30^m$ or 45^m A.M.	Ditto	More shocks, lasting some seconds.			Ditto.
—— —— About the 20th.	In Murcia and Valencia, in Spain. Especially at Torrevieja.	Severe shocks again forced the inhabitants of Torrevieja to leave their houses.			Authorities quoted above, 13th Sept.; Journal de Frankfort, 1829, Nr. 14.
—— —— 29. 10 A.M.	Macassar in the island of Celebes, and along the south coast.	An earthquake, which lasted two minutes and a half at Macassar.	The sea rose several times to a fearful height, and ebbed and flowed with indescribable rapidity on the strand.	Bulecomba suffered much injury, and the plantations around Macassar were also greatly damaged.	Correspondenzblatt v. u. f. Deutschland, 1829, Nr. 270.
—— —— During the last few days of the month.	Country around Vesuvius.	Slight shocks		Accompanying a renewal of the eruption of March.	Froriep's Notizen, B. xxvi. Nr. 9 (559); Ann. de Chim. et de Phys. t. xlii. p. 347.
——	In New South Wales	A very severe earthquake, lasting five and twenty minutes (!).		Followed by a destructive tempest. Neither the exact date or locality given. I have not been able to find any confirmation of this account.	Ditto.
1829. Jan. Beginning of the month. At night.	Portsmouth in the State of New York.	A slight shock			Preuss, Staatszeitung, 1829, Nr. 62, Beil.
—— —— 4. $10^h\ 30^m$ A.M.	Berne and Freiburg				P. Mérian.
—— —— —— In the evening.	Macassar in the island of Celebes.	Recurrence of shocks (vide 29 Dec.).		No damage done	Corresp. v. u. f. Deutschland, 1829, Nr. 270.
—— —— 15.	Torrevieja in Valencia, Spain.	Four more shocks. Other slight ones occurred from time		During the latter half of this month the eruption of Vesuvius was renewed, and became more energetic.	Authorities quoted under March 21.

		to time up to the 11th of March, when they suddenly ceased until the 21st.			
1829. Jan. Almost every day between 2 and 3 P.M.	Alt-Schamachi in Georgia.	Shocks at the hours mentioned.			Ann. de Chim. et de Phys. t. xlii. pp. 347. 417.
—— —— (Some weeks before Feb. 8.)	Patras in Greece	Shocks almost daily felt at the period mentioned.		Always accompanied by atmospheric disturbances (of what kind?).	Gothaische Zeitung, 1829, Nr. 50. Art. Rom.
—— Feb. 7. 6 A.M.	Island of Martinique	Two shocks			Ann. de Chim. et de Phys. t. xlii. p. 348; Cuvier, Hist. des Sc. Nat. t. v. p. 63 et 64; Constitutionnel, 1 Juin.
—— —— 21, and night between 21 and 22.	Throughout the south of Iceland.	A vibratory shock, followed by others of less intensity on the ensuing days.		Great damage in the inhabited districts lying near Hecla. Some of the peasants' cabins were completely ruined, and others much injured. The winter of 1828–29, which was pretty severe in Europe, was so unusually mild in Iceland that scarcely any ice or snow was to be seen.	Preuss, Staatszeitung, 1829, Nr. 104, Beil.
—— —— 23.	Smyrna	Two shocks, of which one was very violent. Both were horizontal, and in the direction N. to S.			Corresp. d. Würtemb. Landw. Vereins. 3 Heft. 1829, S. 186; Férussac, Bull. des Sc. Nat. t. xxvi. p. 32.
—— —— End of the month.	Stockholm	Some shocks were perceived.			Corresp. d. Würtemb. Landw. Vereins. 4 Heft. 1829, S. 235.
—— Mar. 8. (N.S.) 4h 10m. (According to Erman, March 7, 16h 28m, *true time*, or 16h 40m, *mean time*).	Irkutsk in Siberia, and from lat. 50° to 52° and 54°, or probably extended even further to the south, towards China. Felt at many place from Kiachta to Nischney-Udinsk.	A severe shock from N.E. to S.W. At Kiachta and Troïtsko-Sawks it was so violent that the sentinels could scarcely keep their feet. In the fortress of Tunka, south of Lake Baikal, the vibra-		At Kiachta and Troïtsko-Sawks preceded by a noise like that of the wind in a storm. At Irkutsk Erman could not perceive any effect on the magnetic needle. At the fort Tunka the walls of wooden houses bent, and doors, &c. were forced open. A huge mass of rock on the right bank of the river Irkut fell; the earth opened in many places, and the ice on the river and lake was broken. The oscillations from the 8th to the 22nd were accom-	Poggendorff's Annalen, 2 Reihe. B. xxxix. S. 115, B. xvi. (xcii.) S. 153–157; Preuss, Staatszeitung, 1829, Nrs. 124, 135 u. 151; Ann. de Chim. et de Phys. t. xlii. p. 348; v. Humboldt, Asie Centrale, t. ii. p. 111–113, &c.

1.	2.	3.	4.	5.	6.
		tions lasted three minutes. Other oscillations followed, up to the 22nd, occurring many times a day, and sometimes lasting two minutes. At Irkutsk there was first a tremulous motion of the walls, and then a sort of vibratory blow, as when a heavy door is slammed to, followed again by tremulous motion. In Nischney-Udinsk the shock was also very severe.		panied by an extraordinary subterranean noise. At Irkutsk a clattering noise was heard before the shock, which noise lasted eight or ten seconds, and seemed to recur according to a certain rule. The noise was heard very loudly in high buildings, but upon level ground and at a distance from houses it was not perceived at all, whence Dr. Erman concludes that it was an atmospheric not subterranean sound. The sky had been clouded for some weeks before the earthquake, a phænomenon very unusual at this season at Irkutsk, where it is usually clear and dark blue. It was said by an inhabitant of the place that the cloudy sky at this season was a common antecedent to earthquakes.	
1829. Mar. 19. 0h 30m A.M.	Maling in Dalecarlia, Sweden.	A violent earthquake, from N.W. to S.E.	....	Accompanied by loud noise in the air	Preuss, Staatszeitung, 1829, Nr. 117; Corresp. d. Würtemb. Landw. Vereins. 4 Heft. 1829, S. 235; Journ. des Débats, 4 Mai.
—— —— 21. 5h 20m A.M.	Kingston in Jamaica ...	Two shocks from E. to W., as violent as those of 1812.	....	....	Preuss. Staatszeitung, 1829, Nr. 223; Cuvier, Hist. des Sc. Nat. t. v. p. 63, &c.
—— —— — 6h 30m P.M. At Madrid, 6h 20m.	In the province of Murcia, Spain. Slightly perceived at Madrid, and at Beas de Segura in La Mancha. The valley of Segura seems to have been the centre of disturbance; there the shocks were most violent. M. Cassas, French consul at Alicant, supposed the	Preceded by a slight shock at noon. That at 6h 30m was the most violent of all those felt here this year, and was followed by more than a hundred others during the night. At Torrevieja the motion was undulatory, and forty-	Shocks were felt on board vessels at sea off the coast, fourteen miles N.E. from Torrevieja, at 6h 47m, 6h 51m, 7h 3m, and 7h 5m. The last was very severe, and lasted forty-eight seconds.	The damage done was enormous in very many towns and villages of Murcia, and in Guardamar, La Mata, and Torrevieja in Valencia, some places were totally ruined, and the destruction of churches and houses, and loss of life, were terrible. The premonitory noise like thunder was heard at Torrevieja for more than three-quarters of an hour. It generally resembled the explosion of a cannon, and sometimes increased gradually and then suddenly ceased. It was not heard there after the 21st of March until September following. At Daja Nueva	Moniteur, 10 Juillet, 20 Août, 13 Nov.; Journ. des Débats, 9 et 12 Avril; Constitutionnel, 9 et 15 Avril, 21 Juin, 6, 11 et 30 Oct.; Ann. de Chim. et de Phys. t. xxxix. p. 411, t. xlii. p. 348, t. xlv. p. 396; Gazeta de Bayonne, 1829, Nrs. 28. 35. 52. 54. 55. 56. 57. 58. 73. 74. 79. 114; Ann. des Sc. Nat. t. xvii. 1 série, p. 105; Preuss. Staatszeitung, 1829, Nrs. 102. 107. 109. 111. 119. 136. 225;

	shock to be vertical, from beneath, in the district lying between Orihuela and the sea, thus making this the centre.	eight shocks were counted between 5 P.M. and 6 A.M. the next morning. They continued with the same frequency up to the 26th, and until the 16th of April thirty or forty shocks or accompanying noises were observed. At Madrid an oscillatory motion, apparently from E. to W. or S.E. to N.W., lasting some seconds. At Grenada the motion was observed to be from E. to W., or *vice versâ*. At Murcia and in the whole district shaken on the 21st, shocks of more or less severity recurred daily up to the 30th.		and Daja Vieja fissures opened in the earth, and small holes appeared, from some of which large quantities of dry sand, and from others of sand and water, were thrown out. In Estremadura the water of a lake suddenly disappeared. On the right bank of the Segura, it was remarked, the shocks were more numerous and lasted longer than on the left. The course of this river has changed, and now enters the sea at a different place from its former mouth. In Madrid the shock was sufficient to set chandeliers, &c. in motion.	De Cabrerizo, Los Terremotos de Orihuela, Valencia, 1829, 8vo, &c.
1829. Mar. 22.	Ancona in the States of the Church.	Two severe shocks ...	....	Accompanied by noise like the firing of artillery. No damage done.	New Monthly Magazine, 1829, Nov. p. 487; Moniteur, 18 Avril.
—— —— 23. 2h 30m (A.M.?)	Kingston in Jamaica ...	Another shock. Two others during the night.	....	....	Cuvier, Hist. des Sc. Nat. t. v. p. 63; Constitutionnel, 1 Juin, 21 Juillet; Moniteur, 21 Juillet.
—— —— 24.	Ditto	Another shock; slight	....	....	Ditto.
—— —— 27. 4h 30m A.M.	Ditto	Another of great severity.	....	....	Ditto.
—— —— 31. 4h 30m P.M.	Port-au-Prince in St. Domingo.	Two severe shocks ...	....	....	Ditto; Ann. de Chim. et de Phys. t. xlii. p. 348.
—— April 1. 2 A.M.	Madrid........................	A shock	....	....	Authorities quoted under March 21.

1.	2.	3.	4.	5.	6.
1829. April 2. $7^h\ 30^m$ A.M.	Dieppe and the neighbourhood, departm. Seine-Inférieure.	Several severe shocks; the first lasted several seconds.		The first shock was accompanied by noise like thunder.	Ann. de Chim. et de Phys. t. xlii. p. 348.
—— —— 6. 2 A.M.	In Murcia, Spain	More vibrations, lasting twelve seconds, and followed, two hours later, by another slighter shock.		Accompanied by noise lasting ten seconds	Authorities quoted under March 21.
—— —— 7. 1 A.M.	Petropawlowsk in Siberia.	A shock			Preuss, Staatszeitung, 1829, Nr. 243.
—— —— 10.	Pontferrada in Leon, Spain.	An earthquake		Preceded by a violent storm of rain and snow...	Ditto, Nr. 129; authorities quoted under March 21.
—— —— 13. 4 P.M.	Island of Thassis and the opposite coast of Macedonia, Turkey, extending as far as Adrianople.	The first and principal shock was horizontal, and came from the N.W. It was succeeded by other slighter ones until the next day.	Felt on board the ship of the Russian admiral 'Ricord,' off the coast of Thassis.	A tower and several houses on the coast were thrown down. The village of Pravi, seven or eight miles inland, lost seventy houses, and the village of Xanthy with its inhabitants was nearly swallowed up by the earth. In Adrianople some minarets and houses fell. The shock was preceded by a gust of wind from the S.E. In the island of Thassis bottles and glasses were thrown off the table.	Casselar Allgem. Zeitung, 1829, Nr. 158. S. 816, quoting Courrier de Smyrna, 26 Avril.
—— —— About the middle of the month.	Near Mount St. Helie in Messenia, Greece.	A slight shock, lasting some seconds.			Communication of M. Aug. Brullé to M. Perrey.
In the morning —— —— 16. 7 A.M.	In Murcia, Spain; places shaken on the 21st of March.	A very severe vibratory shock.			Authorities for the 21st of March.
—— —— 17.	Ditto; at Orihuela and some other places in same district.	More shocks			Ditto.
—— —— 18. $9^h\ 45^m$ A.M.	Ditto. Felt at Villajosa (Valencia) and Carthagena.	Shocks almost as violent as those of March 21. They lasted fourteen minutes without interruption at Almoradi and Torrevieja.		Caused new misfortunes at Almoradi, Torrevieja, Salinas, and Guardamar.	Ditto.

1829. April. Night between 18 and 19.	Malung in Dalecarlia, Sweden.	A severe shock		Accompanied by a noise in the air. This account probably refers only to the event of March 18, 19.	Corresp. d. Würtemb. Landw. Vereins. 5 Heft. 1829, S. 289.
—— —— 21. (Six weeks after the shocks of March.)	In the mines of Zyrianowsk and Riddersk, on the banks of the Maglenka and Oulba, in the southern part of the Altai, Siberia.	Shocks which were very considerable at the bottom of the mines.		M. Gelher of Barnaoul says that earthquakes are more frequent in this district than elsewhere in the government of Tomsk, which he attributes to the proximity of the hot springs Rakhmanowka, which rise thirty-seven leagues to the east of Riddersk. v. Humboldt says that Riddersk is the extreme western limit of the Altai earthquake region.	v. Humboldt, Asie Centrale, t. ii. p. 111–113; Fragments Asiatiques, t. i. p. 126. 136.
—— —— 23. $9^h\ 30^m$ P.M.	Freyburg and Münsterthal ($2\frac{1}{4}$ miles S. by W. from Freyburg), in Baden.	A rather severe vibratory shock, lasting some seconds, and apparently in the direction S.W. to N.E.		Accompanied by noise like thunder. Both the noise and shock were perceived in the mines near Münsterthal. At Freyburg a severe storm from the N.W. with snow followed immediately after. On the 2nd of May a large mass of rock fell in the Falkensteige, in the district of Freyburg.	Preuss, Staatszeitung, 1829, Nr. 126.
—— —— 24. 1^h and $1^h\ 20^m$ P.M.	Almoradi and the environs, in Murcia, Spain.	Renewed severe shocks.		Heavy rain fell almost the whole month through in Spain, producing great inundations.	Authorities for 21 March.
—— —— ...	Jackson (County?), Tennessee, United States.	Rather severe vibratory shock, of long duration.			Preuss, Staatszeitung, 1829, Nr. 181, Beil.
—— May 2.	Again in the province of Murcia, Spain.	No less than fifty-one shocks on this day.		An account from Madrid of the 4th says that severe shocks had been felt at Puebla de Senabria not far from Valladolid, no damage done.	Authorities quoted above for March 31; Allgemeine Zeitung, 1829, Nr. 140. S. 557.
—— —— 4.	In the mountains of Albano, near Rome.	Vertical shocks			Corresp. d. Würtemb. Landw. Vereins. 6 Heft. 1829, S. 337.
—— —— 5. After noon.	On the coast of Macedonia and Thrace. Felt from Salonichi to Constantinople, and at the same time even in Bucharest. Most violent in the southern part of the district shaken.	Several violent shocks, which at Salonichi frequently recurred until the 10th. At Adrianople the motion of the earth had continued almost every day from the 13th of April to the 5th of May.		In Salonichi, houses, mosques, and part of the town walls were thrown down. The little town of Drama was totally destroyed, and many of the surrounding villages were much injured. The towns of Kawala and Seres also suffered much. A mountain about ten miles from Drama suddenly poured forth a kind of reddish water.	Preuss, Staatszeitung, 1829, Nr. 188, Beil.
—— —— 15 to 17.	Torrevieja in Murcia, Spain.	Fifty-three more slight shocks.			Authorities for the 21st March.

1.	2.	3.	4.	5.	6.
1829. May 19. 9 P.M. to 2 A.M. of the 20th.	City of Mexico	Six violent shocks in the time mentioned. They recurred at intervals for two or three days.			Moniteur, 5 Août.
—— —— Night between 21 and 22.	Albano, Genzano, La Riccia, and especially Castel, Gandolfo. in the States of the Church.	Some shocks, followed by others for several days, the whole number amounting to fourteen or sixteen.		Houses were violently shaken, and one thrown down.	Journ. des Débats, 13 et 23 Juin; Moniteur, 23 Juin; Férussac, Bull. des Sc. Nat. t. xxvi. p. 32; Preuss, Staatszeitung, 1829, Nr. 165; Ann. de Chim. et de Phys. t. xlii. p. 348, 349.
—— —— 22. 10^h 45^m A.M.	Gräz in Austria. Felt in many parts of the town, and several of the suburbs. Not at all felt in the suburbs on the right bank of the Mur.	A rather violent shock, in the direction N.E. to S.E. (?). Also said to have been perpendicular, and to have lasted about a second.		Preceded by uninterrupted rain for eight days, which began again heavily immediately after the shock, but lasted only half an hour. The sky then cleared, and fine warm weather set in. In some places the shock seemed as if a heavy weight had been let fall on the roof. No damage done.	Preuss, Staatszeitung, 1829, Nr. 157.
—— —— 23. 5 P.M.	Constantinople and Scutari.	Two shocks		No damage was done in Constantinople, but on the Asiatic side buildings were injured. The castles of the Dardanelles also received some injury.	Casseler Zeitung, 1829, Nr. 184. S. 955.
—— —— 29. 11^{h}48^m (A.M.?)	Island of Jamaica	A very severe shock, followed frequently by others up to June 7.			Preuss, Staatszeitung, 1829, Nr. 203; Moniteur et Constitutionnel, 21 Juillet, &c.
—— —— ...	In the town (County?) of Jackson, Tennessee, United States.	Rather violent earthquake.		This account and that of April probably refer to one and the same event. The month of May was marked by storm and rains in many parts of Europe.	Corresp. de Würtemb.; Landw. Vereins. 8 Heft. 1829, S. 115.
—— June 1.	Albano in the States of the Church.	Several shocks on this and some preceding days, more severe than those of May. At 10 A.M. a slight shock from E. to W. was felt at Bonn (in all probability Rome).		Some damage done at Albano	Preuss, Staatszeitung, 1829, Nr. 170; Journ. des Débats, 13 et 23 Juin; Moniteur, 23 Juin; Férussac, Bull. des Sc. Nat. t. xxvi. p. 32.

1829. June 1 to 5.	Torrevieja in Valencia, Spain.	Sixty-eight shocks in the period mentioned, of which thirteen were very severe.		On the 7th a violent storm of rain, producing inundations.	Authorities for March 21.
—— —— Night between 2 and 3.	On the Schneekoppe, Riesengebirge.	Three shocks		On the 2nd the usually clear mineral waters of Warmbrunn in Silesia appeared blue and milky.	Dorfzeitung, 1829, Nr. 110; Preuss, Staatszeitung, 1829, Nr. 169, B, Nr. 175, B.
—— —— 4.	Lunröe in Norway	A feeble shock			Keilhau.
—— —— Night between 8 and 9.	In the mountains of Albano near Rome.	Shocks			Corresp. d. Würtemb. Landw. Vereins. 7 Heft. 1829, S. 53.
—— —— 10 to 15.	Torrevieja in Valencia, Spain.	Twenty-four more shocks, of which one was terrible and almost as severe as that of March 21.			Authorities for March 21.
—— —— 13.	Albano in the States of the Church.				Moniteur et Journ. des Débats, 23 Juin; Férussac, Bull. des Sc. Nat. t. xxvi. p. 32.
—— —— In the middle of the month.	Island of St. Thomas in the West Indies.	An earthquake			Corresp. d. Würtemb. Landw. Vereins. 8 Heft. 1829, S. 116.
—— —— 17. In the evening.	At Murcia in Spain	Six shocks			Authorities for 21st March.
—— —— 18.	Ditto	Two more shocks, followed by others the next day.			Ditto.
—— —— 19. At sunrise.	Almoradi in Murcia	A severe shock, followed by a slighter one at 6 A.M., and by another at 6^h 30^m P.M.			Ditto.
—— —— 24. 7^h 10^m P.M.	Paris	Several vibratory shocks, on the authority of some people living in the Rue du Mont, Parnasse.			Journ. des Débats, 5 Juillet; Constitutionnel, 4 Juillet; Ann. de Chim. et Phys. t. xlii. p. 349.
—— —— 26.	Caen in the departm. Calvados, and the neighbourhood.	A slight shock, lasting two seconds.			Ditto.

1.	2.	3.	4.	5.	6.
1829. June 28. About 8 P.M.	Orihuela and San-Pedro-del-Pinadar, in Murcia, Spain.	Violent earthquake. Although of diminished severity the shocks were still frequent at Orihuela.			Authorities quoted under 21 March.
—— July 1.	Debreczin, Vamos, Perts, Karczag, Nagy-Karoly in the county of Tabolsc, Szathmar, Erlau, and several other places in Hungary, included in a district of about forty-five geographical miles from E. to W., by ten from N. to S.	Several shocks. At Debreczin the first shock occurred about 2^h after midnight; at $4^h 24^m$ A.M. two more of greater severity; and in the evening at 8^h 28^m P.M., three violent horizontal shocks in the direction E. to W. At Nagy-Karoly the first shock was at 4 A.M., and at 8^h 40^m P.M. there were two more, vibratory, from N.E. to S.W. or S.W. to N.E; each of these vibrations lasted two seconds, and the interval between them was about the same. The shocks recurred at these places on the 2nd and 7th July. In Debreczin no shock had been felt since 1746.		At Debreczin the day before had been sultry and rainy; heavy rain also fell in the forenoon of the 1st; and at the time of the shocks felt in the evening there were reddish clouds in the horizon, and an appearance of a light for two seconds like lightning was observed. These last shocks were accompanied by subterranean noise. At Nagy-Karoly the shocks at the same time (8^h 40^m P.M.) were accompanied by a noise compared to that of a waggon laden with empty casks. At this place loose articles were set in motion, the springs disturbed and muddied (perhaps produced only by the preceding heavy rain), and various animals, particularly cats and dogs, rendered very uneasy. The barometer was not affected. The storms, thunder and lightning, rain, and hail, of this month and the preceding were very remarkable in many parts of Europe. vid. v. Hoff.	Preuss, Staatszeitung, 1829, Nr. 200, Nr. 218, B, Nr. 235.
—— —— 2.	In the province of Murcia, Spain.	Repeated shocks			Authorities quoted for March 21.

In the beginning of the month.	in company	Shocks	On the 8th at 10 P.M. a very high tide at Marseilles.	....	Corresp. d. Würtemb. Landw. Vereins. 8 Heft. 1829, S. 183; Constitutionnel, 17 Juillet.
—— —— Night between 3 and 4.	Zwolle in Ober-Yssel, Holland.	A slight shock........	....	The weather had been stormy before, but at the time of the shock it changed to a perfect calm.	Preuss, Staatszeitung, 1829, Nr. 197.
—— —— 15.	Vitry and in the department de l'Aube, France.	An earthquake	....	v. Hoff mentions a severe hailstorm in this district, but does not speak of an earthquake.	Communication of M. Aug. Bravais to M. Perrey.
—— —— 24. Between 10 and 11 P.M.	Almoradi and the neighbourhood, Murcia, Spain.	More shocks	....	A violent storm of lightning, and hail of unusual size (some of the hailstones weighing 10 or 12 oz.), during intense heat.	Authorities for 21st March.
—— —— 27. About 1 P.M.	In the district of Hungary shaken on the 1st.	Three more shocks........	....	....	Corresp. d. Würtemb. Landw. Vereins. 8 Heft. 1829, S. 184.
—— —— 30. 5h 15m P.M.	Neusohl in Hungary	An earthquake........	....	No damage done........	Preuss, Staatszeitung, 1829, Nr. 235.
—— Aug. 3.	Lunröe in Norway	Two more shocks	....	....	Keilhau.
—— —— 4. 2 A.M.	In Hungary again	Undulatory shocks, lasting four seconds.	....	Great damage done to buildings, especially at Nagy-Karoly, Endred, Dengeley, Zriny, and Portelek. No earthquake had been observed in this region for 100 years before.	Corresp. d. Würtemb. Landw. Vereins. 8 Heft. 1829, S. 237.
—— —— 7. 3 A.M.	Colmar, St. Dié, Strasburg, Belfort, Pontroy, and several other places in Alsace. Most severe at the two last named places.	Several shocks, in the direction N. to S.	....	Accompanied by a noise like distant thunder. More strongly felt in the mountains than in the low country.	Le Globe, 9 Sept.; Férussac, Bull. des Sc. Nat. Oct.; Ann. de Chim. et de Phys. t. xlii. p. 349; Corresp. d. Würtemb. Landw. Vereins. 8 Heft. 1829, S. 237.
—— —— 17. (or 18?) 3h 30m P.M.	Copenhagen, Gothenburg, Christianshavn, and Amager, in Denmark.	A rather severe shock. In Copenhagen it lasted several seconds, and came from the N.W.	Also felt on board a steam-vessel at anchor off Dobberan.	In Copenhagen preceded by a hollow sound like that of a carriage passing under a gate-way. Moveable articles and even the walls were caused to oscillate. No effect on the barometer. This was the first shock felt in Copenhagen since the date of the great earthquake of Lisbon.	Preuss, Staatszeitung, 1829, Nr. 238 u. 249; Moniteur, 3 Sept.; Ann. de Chim. et de Phys. t. xlii. p. 349; Keilhau.
—— —— 20. 6h 55m P.M.	Port Antonio in Jamaica	Two slight shocks (another account says, a severe earthquake).	....	....	Preuss, Staatszeitung, 1829, Nr. 315; Ann. de Chim. et de Phys. t. xlii. p. 348; Cuvier, Hist. des Sc. Nat. t. v. p. 63.
—— —— Night between 31 and Sept. 1.	Verkotoemsk in the government of Wologda and Chenkoursk in	In Wologda, three vibratory shocks in fifteen minutes. In	....	During calm weather in Wologda, accompanied by subterranean noise. The buildings oscillated, and the lamps were thrown off from a	Preuss, Staatszeitung, 1829, Nr. 353; v. Humboldt, Asie Centrale, t. ii. p. 119; Moniteur, 31 Déc.

1.	2.	3.	4.	5.	6.
	that of Archangel, Russia.	Archangel there were but two shocks.		freely suspended chandelier. In Archangel, no noise and no damage done. The storms of July still continued in many parts of Europe.	
1829. Aug. Night between 31 and Sept. 1.	New South Wales	A violent earthquake.		During a dreadful tempest. The earth was raised up in waves like the sea, forming in many places terrible fissures.	Asiatic Journal.
—— Sept. 1. 2^h 30^m P.M.	In the island of Erromanga, one of the New Hebrides.	A trifling shock			Ditto, N. S. vol. vii.
—— —— 4. 11^h 45^m A.M.	Island of Martinique	Ditto			Moniteur, 8 Nov.; Constitutionnel, 16 Déc.
—— —— 6. 3^h 25^m P.M.	Cremona in Italy	Rather a severe earthquake in the direction S. to N., consisting of several oscillations of about four seconds' duration. At 8^h 15^m P.M. the oscillations recurred, and lasted three seconds.		Accompanied by subterranean noises, as were the shocks at 8^h 15^m. Cracks opened in several places in the vault of the church of St. Dominica, several other buildings were injured, and bells were made to toll. The sky was cloudy, and the wind from the N.; soon after the sky cleared and the sun shone forth.	Preuss, Staatszeitung, 1829, Nr. 263.
—— —— 9. 10^h 30^m A.M.	Frankfort on the Maine.	A shock, from S.W. to N.E.		v. Hoff doubts this account, as a kind of whirlwind passed over the city at the same time, to which he ascribes the report of an earthquake.	Ditto, Nr. 259, Beil; Allgemeine Zeitung, Nr. 258, Beil. S. 1031; Constitutionnel, 17 Sept.
—— —— 10.	In the neighbourhood of Granada, Spain.	Three shocks			Authorities under March 21.
—— —— 14. 9^h 45^m P.M.	Island of Martinique	Two shocks, of which the second was violent. Direction = S. to N.	On the 26th and 27th of October a violent "raz de marée" on the coast of Martinique.		Moniteur, 8 Nov.; Constitutionnel, 16 Déc.
—— —— 14 to 19.	Torrevieja in Valencia, Spain.	At least fifty shocks in this period.			Authorities for March 21.
—— —— 24. 11 A.M.	Murcia, Orihuela, and the neighbourhood.	An earthquake which recurred during the following night.		Storms and heavy rains continued to prevail in many parts of Europe during this month. Vid. v. Hoff.	Ditto.
—— Oct. Beginning of	Aubonne in the Canton du Vaud, Switzerland.	Several shocks		A brilliant meteor was also observed here which disappeared with a loud explosion. Followed	Corresp. d. Würtemb. Landw. Vereins. 12 Heft. 1829, S. 324.

the month. (M.P. Mérian gives the date Oct. 10, 10^h 30^m P.M.)				by gusts of wind and snow showers.	
1829. Oct. 5. 10^h 5^m A.M.	In the district of Mürzzuschlag, circle of Bruck, Styria. Extended as far as the Austrian territories.	An earthquake, whose direction was N.E. to S.W.		Threw down a piece of wall	Preuss, Staatszeitung, 1829, Nr. 297, Beil.
—— 9.	Lunröe in Norway	Two shocks			Keilhau.
—— 12. 11 P.M.	Gessenay, Saanen, in the canton of Berne, Switzerland.	A rather severe shock.		Accompanied by subterranean noise, which seemed to come from different quarters. The beds trembled. The same day a great cleft opened in a mountain in the valley of Six. On the 15th also the earth sank, and clefts appeared on Mount Blonay in the Canton du Vaud.	Journ. des Débats, 1 Nov.; Ann. de Chim. et de Phys. t. xlii. p. 349; Preuss, Staatszeitung, 1829, Nr. 308.
—— 13.	Murcia, Orihuela, &c., in Spain.	More shocks			Authorities for March 21.
—— 19. (According to some, the 20th.)	Granada in Spain	At 1 A.M. a slight movement, scarcely perceptible; at 4^h 15^m another shock, stronger, but lasting only half a second. At 3^h 45^m P.M. a third shock, of equal force and duration.		Accompanied by subterranean noise. No damage done.	Ditto.
—— 24. 4 A.M.	Ditto	Another shock, the last recorded of the long series of disturbances this year in Spain.		Besides the violent storms of wind and rain of this year several other unusual phænomena had been observed in Spain, as luminous meteors, halos round the sun and moon, extraordinary and unseasonable alternations of heat and cold, &c.	Ditto.
—— 26. (The date *Sept.* 26 is also given.)	Valparaiso and Santiago in Chili.	A shock nearly as violent as that of 19 Nov. 1822, but of much shorter duration, lasting but twenty seconds.		In Valparaiso a great many houses were more or less ruined, and in Santiago, where the earthquake was more violent, many persons lost their lives. The village of Casa Blanca, thirty miles from Santiago, was completely ruined. The destruction of buildings was however not so great as in 1822.	Preuss, Staatszeitung, 1830, Nr. 49, Beil. S. 351; Froriep's Notizen, B. xxvii. Nr. 12. S. 186; Ann. de Chim. et de Phys. t. xlv. p. 398; Leonhard und Bronn. N. Jahrb. 1834. S. 459.

1.	2.	3.	4.	5.	6.
1829. Nov. 2. $10^h 30^m$ A.M.	In the circle of Neustadt, kingdom of Illyria.	A vibration, lasting five seconds.			Corresp. d. Würtemb. Landw. Vereins. 12 Heft. 1829, S. 325.
—— —— 9. (O.S. or N.S.?)	Barnaoul in the Altai Mountains, Siberia.	Severe subterranean disturbances.			v. Humboldt, Asie Centrale, t. ii. p. 112.
—— —— 16.	Lunröe in Norway	Two shocks			Keilhau.
—— —— 19.	Ditto	Another slight shock.			Ditto.
—— —— 20. 4 A.M.	Jassy in Moldavia	Severe shocks, lasting seventy seconds, accompanied by horizontal motion from W. to E. Another, very slight, shock between 7 and 8 P.M.		Accompanied by subterranean noise. Houses were thrown down.	Vid. *inf.* authorities for Nov. 26.
—— —— 23.	Bucharest and neighbourhood.	Violent shock		Accompanied by strong atmospheric perturbations. A hundred and fifty houses of stone were thrown down.	Ditto.
—— —— 25.	Ditto	Ditto			Ditto.
—— —— —— $8^h 30^m$ P.M.	In the circle of Neustadt, Illyria.	Another vibration, lasting four seconds.			Corresp. d. Würtemb. Landw. Vereins. 12 Heft. 1829, S. 325.
—— —— 26. About 4 A.M. (At Hermannstadt, $3^h 30^m$; at Mediasch in Transylvania, $3^h 45^m$; at Jassy, Kiew, Jekaterinoslaw, Reni, Ismail, and Akierman, 4 A.M.; at Chorol in the government of Pultawa, $5^h 45^m$ (?); at Odessa, $3^h 33^m$ (*true time* known	Extended over a very large district, from Transylvania to Kieff in Russia. The limits were, to the W., Hermannstadt, Czernowitz, and Bucharest; to the E., Kiew and Jakaterinoslaw; comprising a district of about 100 geographical miles from S.W. to N.E., by forty from S. to N. *Said* also to have been slightly felt in the Bannat. Most violent in Bucharest and the surrounding country, and generally	A violent earthquake. At Hermannstadt the oscillation of the earth seemed to be from N.E. to S.W. There were more than 12 (or 72?) shocks, of which the last three were the most severe. At Mediasch there were four oscillations from N.W. to S.E. in eight or ten minutes. At Jassy the earthquake was very severe; the motion horizontal, from W. to E.; be-		At Bucharest and Kimpina (on the way to Kronstadt, where the shock was also felt) many buildings were ruined or much injured. At Hermannstadt preceded by a dull noise like that of violent wind, which recurred thrice. Glasses, presses, &c. were strongly shaken. At Mediasch bells were caused to ring. At Czernowitz a strong wind had arisen at midnight, and continued up to about 3 A.M., but had quite gone down before the earthquake. At this place and in the greater part of Moldavia a heavy fall of snow followed the shocks. At Jassy a dull subterranean noise passing from W. to E. was heard. Large cracks appeared in many of the buildings and chimnies fell. At Kischenow, Dabossary, Reni, Tiraspol, and Cherson more or less damage was done to buildings. At Kiew some articles of furniture were moved about. At Jekaterinoslaw	Preuss, Staatszeitung, 1829, Nr. 356, Beil, Nr. 359, Nr. 353, Beil, Nr. 347, Beil, Nrs. 350. 348. 352. 358. 360; Allgemeine Zeitung, 1829, Nr. 355. S. 1420, Nr. 358, Beil; Journ. des Débats, 26, 27 et 29 Déc.; Moniteur, 20, 23, 29 et 30 Déc.; Constitutionnel, 22, 26 et 27 Déc., et 18 Janv. suiv.; Ann. de Chim. et de Phys. t. xlii. p. 349, t. xlv. p. 398; Férussac, Bull. des Sc. Nat. t. xxiv. p. 146; Mém. de l'Acad. Imp. de St. Pétersbourg, ser. 6. t. i. p. 4.

within half a minute at least).	In the S.W. part of the region shaken.	tween 7 and 8 P.M. another, very slight, vibration was felt. At Kischenew in Bessarabia the motion lasted three minutes. At Kiew, four minutes. At Chorol the vibrations were slight, but lasted ten minutes. At Jekaterinoslaw the duration of the motion was some seconds only. At Reni and Ismail the shock recurred at 8 P.M. At Otschakoff a shock was felt at 3 A.M., but nothing at 4. At Iwanowka the shock was very severe. At Odessa Haüy was wakened by slight oscillations, which lasted about two-thirds of a minute, and were followed by a pretty severe shock of some seconds' duration. After renewed oscillations for about a minute, there came a second, very severe, shock, which lasted longer than the former. The oscillations then again decreased and		the motion was more strongly felt in the higher parts of the town than in the lower, and, in a stone building situated on an eminence, the south side only was injured, while the north suffered not at all. At Nikolajew accompanied by subterranean noise, like boiling. At Odessa the barometer was carefully observed during the earthquake, but did not show the least change. The magnetic needle could not be observed.	

1.	2.	3.	4.	5.	6.
		increased for twelve or fifteen seconds, a third shock, shorter and weaker than the first, occurred, then again the oscillations, and then the last shock, equal to the third, and lasting three or four seconds. Then a decreasing tremulous motion for about 1¼ minute, and at $4^h\ 2'\ 2''$ all was still again. Haüy counted 152 vibrations in thirty seconds. The direction was found by a water bottle in which the water, raised by the shock, had washed off some of the dew on opposite sides of the glass. The line joining the two highest points of the curves thus produced on the dewy glass lay 2° west of the astronomical meridian.			
1829. Nov. 27. $4^h\ 5^m$ P.M.	La Rochelle and Rochefort, in the departm. Charente - Inférieure, France.	A slight vibration, followed, a second later, by another of great severity. No distinct *shock* or	The crews of three ships reported that at the moment the vibration was felt on land they	Preceded by two loud explosions; the first was of but moderate intensity, but the second was of extraordinary violence and lasted one or two seconds. It was followed by a prolonged booming noise, probably the effect of echo.	Ann. de Chim. et de Phys. t. xlii. p. 350; Férussac, Bull. des Sc. Nat. Avril 1830.

		blow was felt.	imagined their vessels had touched the bottom.	This and the explosions lasted at most four or five seconds. The explosions seemed to take place high in the air towards the south, and were quite unlike thunder, but were supposed by many to have arisen from the explosion of a powder magazine. The vibratory motion made the windows rattle, and moved some few articles which did not stand firmly. Several animals exhibited unusual restlessness a moment before the noise was heard. The barometer had been very low, and remained quite steady at the time of this phænomenon, but soon after began to rise.	
1829. Nov. 27.	Mondavio and Todi in the States of the Church.	A vibratory shock ...	....	Preceded by a violent gust of wind	Preuss, Staatszeitung, 1829, Nr. 353, Beil.
—— —— 29.	Ditto	Ditto	....	....	Ditto.
—— —— 30. 8 P.M.	Innsbruck in the Tyrol.	A slight, almost vertical shock.	....	The day was calm and foggy. The barometer was not affected by the earthquake.	Ditto, Nr. 346.
—— Dec. 1. 2 A.M.	Ditto	Ditto	....	....	Ditto.
—— —— 6. 5 A.M.	La Rochelle and the environs for three or four leagues round. Also in Medoc, and other districts of the departm. Gironde.	A rather severe shock.	....	....	Ann. de Chim. et de Phys. t. xlii. p. 350; Férussac, Bull. des Sc. Nat. Avril 1830.
—— —— 9. 4h 30m A.M.	Santa Fé-di-Bogota in Columbia, S. America. Also felt at Santa Anna, Honda, Cartago, and la Vega de Tupia; thus over a space of 6° of longitude, between the eastern and central chain of the Andes.	A slight vibratory shock, lasting four or five seconds.	....	....	Ann. de Chim. et de Phys. t. xlv. p. 402.
—— —— 10. 8h 55m P.M.	In the circle of Neustadt, Illyria.	Another shock, the most violent of the three felt since November 2. Lasted four seconds.	....	....	Corresp. d. Würtemb. Landw. Vereins. 12 Heft. 1829, S. 325.

1.	2.	3.	4.	5.	6.
1829. Dec. 22.	Belley in the departm. de l'Ain, France.	A shock of considerable severity and long duration.			Ann. de Chim. et de Phys. t. xlii. p. 351.
—— —— A few days before the 28th.	Country around Vesuvius.	Some tremblings of the ground.		Accompanied by subterranean noise like boiling. The volcano began to throw forth flame and stones, but no lava appeared.	Moniteur, 1830, Nr. 20. p. 78, Nr. 21. p. 81.
—— —— 29.	Belley in the departm. de l'Ain, France.	Another shock			Communication of M. Aug. Bravais to M. Perrey; Modenzeitung, 1830, Nr. 6. S. 48.
—— —— Day not given. Towards morning.	Hermannstadt in Hungary.	A very violent shock, which lasted a minute.		The weather was very cold up to the time of the shock, but became warm afterwards. For the various storms and other violent meteorological disturbances of this year vid. v. Hoff.	Ann. de Chim. et de Phys. t. xlii. p. 351.
1830. Jan. 8.	Near Waldheim in Saxony, on both banks of the Tschopa.	A slight shock	On the 10th the sea rose suddenly to an unusual height on the west coast of Holland, and caused considerable injury to the dykes, &c. v. Hoff.	Accompanied by subterranean noise. On the 7th the water of the lake near Salzungen in the Duchy of Meiningen was strongly agitated, so that ice of 2 feet thick upon it was broken. v. Hoff.	Dorfzeitung, 1830, Nr. 23.
—— —— 26. 3h 30m A.M.	Lucca	A slight vibratory shock, followed by another at about 5h, and a third about 5h 30m. The last two were rather severe and lasted more than 5 secs.			Preuss, Staatszeitung, 1830, Nr. 45. S. 316; Ann. de Chim. et de Phys. t. xlv. p. 402; Férussac, Bull. des Sc. Nat. t. xxiv. p. 152.
—— —— ... Night between 30 & 31.	Gutenstein in the circle of the Wiener Wald, Austria.	A violent vibratory shock.			Preuss, Staatszeitung, Nr. 61, Beil. S. 441.
—— —— ...	Nauplia in the Peloponnesus.	An earthquake			Communication of M. Colla to M. Perrey.
—— Feb. 4. 5h 30m A.M.	Hieflau in the circle of Bruck, Styria. Felt throughout the whole district of Hieflau.	A vibratory shock, followed, in a quarter of an hour, by a violent oscillatory motion, and then a		Accompanied by a noise like that of the wind in a storm. The second shock was attended with a dull noise like thunder. The motion was so violent that people who were in bed thought they should be thrown out on the floor; the	Preuss, Staatszeitung, 1830, Nr. 61, Beil. S. 441.

		oscillation was from N.E. to S.W., and lasted about 5 secs.		cracked; pictures and mirrors swung out from the walls, and loose plaster fell from the ceilings. The day was calm and clouded, but the day before had been clear. No damage to men or buildings ensued.	
1830. Feb. 8. 10h 40m A.M. (The Ann. de Chim. et de Phys. gives the date Feb. 7.)	Agram in Hungary......	A shock of 2 secs. duration.	....	Felt equally in the upper and lower part of the town. In many of the houses cracks appeared in the walls, sheets of glass were broken, plates fell off the tables, and persons who were sitting distinctly felt themselves moved. On the 6th and 7th there had been a heavy fall of snow; the air then became warm and the barometer stood very low. After the shock, about 11h 38m A.M., the sun suddenly shone out with great brilliancy for a few moments, and then the heavens became obscured by clouds as before, and a thick fog of a disagreeable smell prevailed for three hours. From the 12th of November, 1829, to the 7th of February, 1830, the cold was most intense in Central Europe, and great quantities of snow fell, which on its melting produced extensive inundations.	Ditto, No. 53, Beil. S. 381; Ann. de Chim. et de Phys. t. xlv. p. 402.
—— —— 27. 6 A.M.	Lauterbrunnen in the canton of Berne, Switzerland.	A shock in the direction N. to S., lasting 4 secs.	....	....	Moniteur, 22 Mars.
—— ——	Nauplia, Egina, and in Greece.	Several shocks	....	....	Communication of M. Colla to M. Perrey.
—— Mar. 9. (According to others, 12.) N. S. 1h 10m P.M.; at Fort Bournoi, 1h 30m.	Kisljar on the Terek (Caucasus), and still more violently in the village of Andrejewskaja. Also felt at Tiflis, at Fort Bournoi, and at Torki. Said also to have extended to Moscow.	An earthquake, of 10 seconds' duration. At Andrejewskaja the direction of the shocks was N. to S., and they recurred for nine days. At Tiflis also the direction was N. to S., and the motion lasted 20 secs. At Fort Bournoi the	....	In Andrejewskaja a church fell, and more than 400 of the inhabitants were buried beneath the mud roofs of their houses. A cleft was produced in a neighbouring mountain, and one half sank considerably. The shock was followed by a gust of wind lasting 10 minutes. A similar violent wind for 10 minutes was observed at Tiflis. At Fort Bournoi no damage was done, but at Torki 200 houses were ruined and many others injured.	Ann. de Chim. et de Phys. t. xlv. p. 402; Das Ausland, 1830, Nr. 200. S. 800; Preuss. Staatszeitung, Nr. 101. S. 752, Nr. 130. S. 978; Gaz. de Tiflis, Nrs. 17 et 25; Constitutionnel, 25 Juin; v. Humboldt, Asie Centrale, t. ii. p. 119.

1.	2.	3.	4.	5.	6.
		motion was rather severe, and lasted about 2 minutes.			
1830. Mar. 9. 4h (?) 30m P.M.	Astrachan	Shocks lasting together 30 seconds.		Great inundations were produced by the breaking up of the ice on the rivers of the East of Europe at the end of this month.	Authorities quoted above (on the 9th).
—— —— 21. 2h 30m P.M.	Island of Martinique	A shock			Cuvier, Hist. des Sc. Nat. t. v. p. 96; Férussac, Bull. des Sc. Nat. t. xxiii. p. 50; Colla, Giornale Astron. 1833, p. 71; Moniteur, 18 Juin; Eyriès, Nouv. Ann. des Voyages, Juillet, p. 125.
—— —— 29. 11h 30m P.M.	Port-au-Prince in St. Domingo.	A violent shock, lasting more than two seconds.			Ditto.
—— —— 30. 0h 30m A.M.	Ditto	Ditto			Ditto.
—— —— — 1 A.M.	Ditto	Ditto			Ditto.
—— Apr. 1.	At Guatemala	Some shocks			Authorities given under the 21st Apr.
—— —— 4.	Eglisau in the canton of Zürich.	A vibratory shock		On the 6th Vesuvius was in a state of activity	Preuss, Staatszeitung, Nr. 145, Beil. S. 1093.
—— —— 12.	Guatemala	Thirty-five more shocks, some severe, some slight.		Several villages, in particular Amatillian, Pinula, and Petassa, were ruined.	Authorities for the 21st April.
—— —— 14. About 6h 30m P.M.	Island of St. Domingo	Two other shocks, more violent than those of March 29, 30. Duration = 4 or 5 seconds. The first shock was from E. to W., and the second from W. to E.	The shocks were felt on board vessels both in port and on the open sea.	Accompanied by noise like distant thunder when it loses itself in the echoes of mountain ravines. Houses of brick and stone suffered severely. It was remarked that in the Leeward Isles earthquake shocks were generally in the direction of the meridian, *i. e.* either from N. to S. or S. to N.	Authorities for March 21.
—— —— 20. 2 A.M.	Soleure and on the banks of the Aar, Switzerland.	A shock from E. to W.		During a tempest which extended over all Germany and continued up to the night of the 21st.	Preuss, Staatszeitung, Nr. 129, Beil. S. 973, Nr. 116, Beil. S. 874; Mérian; Studer.
—— —— —	Fifteen wersts west of Baku in Georgia.	An earthquake			Preuss, Staatszeitung, Nr. 196, Beil. S. 1502.
—— —— 21.	Guatemala	Fifty-two shocks in			Ditto, Nr. 261. S. 2003; Das Ausland,

4 A.M. to 22, 5 P.M.		the period mentioned, some severe, others slight.			1830. Nr. 315. S. 1256; Férussac, Bull. des Sc. Nat. t. xxvi. p. 32; Colla, Giorn. Astron. 1833. p. 72.
1830. Apr. 23. 9 P.M.	Ditto	A violent shock		Several houses were much injured. A village, 6 leagues from the city, was entirely destroyed.	Ditto.
——— 27.	Ditto	More shocks. They did not cease until the 18th May.		More houses injured	Ditto.
—— May 9.	Teheran in Persia	Several shocks		The city suffered much	Preuss, Staatszeitung, Nr. 174. S. 1320.
——— 11. In the evening.	Eglisau in the canton of Zürich.	A vibratory shock		Accompanied by very loud noise. The houses were caused to rock.	Ditto, Nr. 145. S. 1093; Mérian; Studer.
——— 18.	Reggio in Calabria	Two shocks		Accompanied by subterranean noise. On the 16th a great eruption of Etna.	Moniteur, 21 et 24 Juin; Preuss, Staatszeitung, Nr. 165. S. 1252.
—— June 8.	Kindberg and Mürzzuschlag in Styria.	Shocks			Preuss, Staatszeitung, Nr. 195, Beil. S. 1491.
——— 10. 8 P.M.	Werchne-Udinsk in the government of Irkutsk, Russia.	A rather severe vibratory shock, from N.E. to S.W., lasting about 3 secs.			Ditto, Nr. 258. S. 1974.
——— 19. 9h 30m P.M.	Island of Martinique	A shock			Authorities for March 21.
——— 26. 5h 57m A.M.	Gräz and Bruck in Styria. Also felt at Leoben.	Two shocks, with a very short interval, in the direction S.E. to N.W., accompanied by undulatory motion lasting about a second.		Windows rattled, and plaster fell from the ceilings. The air was calm, but somewhat thick and foggy. The barometer exhibited no particular change.	Preuss, Staatszeitung, Nr. 187. S. 1428.
——— 26 and 27.	In China; in the province of Honan, and the parts of Pe-Tsche-Li between 35° and 37° N. lat., to the south of Pekin.	A violent earthquake. The first shock lasted about 2 minutes, and was soon followed by others more terrible and of greater duration.		Preceded by terrible portents. Some days before the earthquake burning vapours filled the atmosphere, dull explosions were heard in the air, long bands of fire appeared on the horizon (thunder and lightning?), and when the first shock was felt a violent storm of rain and hail burst forth over the land. The consternation produced by the earthquake was so great, that no accurate accounts had been collected of the damage done, but it was known that 12 towns had been swallowed up or more	Garnier, Météorologie, p. 167; Gothaische Zeitung, 1831, Nr. 140.

1.	2.	3.	4.	5.	6.
				or less injured. At the same time the district of Ching-Ting-Fou at the other extremity of Pe-Tsche-Li, was visited by a terrible tempest, with hail of enormous size, and productive of dreadful inundations. It was supposed at Canton that 6000 or 7000 perished altogether in these convulsions of nature.	
1830. June....	At the Cape of Good Hope.	An earthquake	....	Two large masses of rock were detached and rolled down from Table Mountain. The larger mass was estimated at 40 or 50 tons. The accompanying loud noise lasted 45 seconds, and produced much uneasiness in Cape Town.	Das Ausland, 1831, Nr. 115. S. 460.
—— July 1. 5 A.M.	Huszth in the county of Marmarosch, Hungary. The last shock was also felt at Szigeth, and at the mines of Sugatagh and Slatina.	Three extremely severe shocks, followed at 9 P.M. by a very violent one. Direction of the shocks = S. to N.	....	By the last shock (at 9 P.M.) many houses were injured.	Froriep's Notizen, Nr. 544. S. 250.
—— —— 9.	In the island of Ægina..	A slight earthquake	....	....	Preuss, Staatszeitung, Nr. 236. S. 1808.
—— —— 13.	Messina and Catania in Sicily.	Severe shocks	....	....	Garnier, Météorologie, p. 96.
—— Aug. 2.	At Murcia in Spain......	....	....	....	Colla, Giornale Astron. 1833, p. 74.
—— —— 8. $0^h 27^m$ A.M.	Kiachta in Siberia	An earthquake, the direction of which was the same as that of March 8, 1829, namely N.E. to S.W. Consisted of two rather violent shocks.	....	Accompanied by a dull noise, which lasted nearly a minute. No other attendant phænomenon of note was observed, except a visible moisture in the atmosphere (mist?).	Preuss, Staatszeitung, Nr. 275. S. 2107.
—— —— 11.	Clagenfurth and neighbourhood, Scutschach, Forlac, and Loibl; in Carinthia.	An earthquake	....	....	Colla, Giornale Astron. 1833, p. 74.
—— Sept. 1.	Erromanga Bay in the New Hebrides.	A slight vibratory shock, lasting about a minute.	Also felt at sea	....	Das Ausland, 1832, Nr. 202. S. 807.

1830. Sept. 9. $9^h\ 20^m$ A.M.	In the Swabian Alps, especially in a part of the bailiwick of Münsingen. Very perceptible in Hayningen, Zwiefalten, Münsingen, Buttenhausen, Eglingen, &c., throughout the Alps of Zwiefalten. Also felt at Scheer in the bailiwick of Wangen.	A vibratory shock, the direction of which, as well as of those of the following days, was S. to N., stretching probably somewhat to the E. Duration of the shock = 2 seconds.		Articles of furniture rattled together, easily shaken objects were moved, and the plaister fell off here and there from the ceilings. People who were in the house felt as if the whole building were shaken by a direct shock or by a violent thunder-stroke.	Schweigger u. Seidel, N. Jahrbuch d. Chemie, Th. v. S. 279.
—— 10. $7^h\ 48^m$ A.M.	Ditto	Another shock, of equal duration with the last.			Ditto.
—— 12. $10^h\ 45^m$ A.M.	Ditto	Another shock, more violent than either of the two preceding, and lasting three seconds.		At Münsingen, Tübingen, and Stuttgard, the barometer fell about the time of the shock, but, as v. Hoff remarks, this fall was observed over a district of Europe too extensive to render it probable that it was in any way connected with the earthquake.	Ditto.
—— 16.	Manilla in the island of Luçon, Philippine Isles.	Some shocks		During a typhoon	In M. Perrey's Memoir on Earthquakes in the basin of the Rhine, p. 90.
—— 19.	In Ober-Marchthal, at the southern foot of the Swabian Alps	A feeble shock			Schweigger u. Seidel, N. Jahrbuch d. Chemie, Th. v. S. 272.
—— 23. $4^h\ 30^m$ A.M.	Again in the Swabian Alps. Felt, at the same time, at Kalw, in the bailiwicks of Urach, Münsingen, and Balingen, at Onstmettingen, near Ober-Marchthal at the southern foot of the Alps, in the western part of the bailiwick of Saulgau, and in that of Marbach.	At Kalw three shocks quickly succeeding each other were felt. The direction seemed to be W. to E. In the bailiwick of Münsingen, in Hayringen, Buttenhausen, Apfelstetten, Oberwilzingen, and Huldstetten, the same observations were made; the motion passed		Accompanied at Kalw by a rolling noise. Buildings and furniture were made to vibrate. The air was calm. At the other places mentioned in Column 3, houses were also shaken, doors opened, &c. At Buttenhausen the shock was particularly felt in the houses on the water's edge. On the morning of the 22nd the barometer reached its lowest point for the month. From then until the morning of the 23rd it rose rapidly, then fell slowly during the whole day. On the 22nd heavy rain fell all day, with southerly and westerly wind. At the time of the earthquake the rain had stopped, and the sky was clouded, but in the evening	Ditto.

1.	2.	3.	4.	5.	6.
		from W. to E., and lasted six or eight seconds.		the rain began again.	
1830. Sept. 21. 6^h 30^m P.M.	Ditto, particularly at Onstmettingen in the bailiwick of Balingen.	Another shock, the last felt in this region of the Alps.	....	The sky was clouded, and rain fell occasionally. The barometer fell slowly something below its mean height.	Schweigger u. Seidler, N. Jahrbuch d. Chemie, Th. v. S. 272.
—— —— 26.	Lisbon	Two slight shocks, each of which lasted about fifteen seconds.	....	....	Preuss, Staatszeitung, Nr. 305. S. 2354.
—— —— 28.	Oporto	A shock	....	....	Colla, Giornale Astron. 1833, p. 74.
—— Oct. 3.	In the island of Ægina, Greece.	Two feeble shocks ...	....	....	Ditto.
—— Nov. 23. 6 A.M.	In the Duchy of Baden, at Freiburg, Mühlheim, and Lörrach; and at St. Louis, Mühlhausen, Bâle, and Strasburg. Also felt at Berne.	Several shocks, apparently in the direction S.W. to N.E. At Bâle (6^h 4^m) the shock was very violent.	....	Preceded by a noise which began with a dull heavy sound as if a great weight had been let fall, and ending with a rattle as of carriages over pavement. Bedsteads were set in motion, doors cracked, and glasses rang. In the places on the west of the Rhine an explosion like that of a cannon preceded the shock. In the mine "Neue Hoffnung Gottes" at St. Blaise in Baden, the shocks were very strongly felt at 5^h 45^m. For Strasburg some accounts give the date Nov. 24 instead of 23.	Dorfzeitung, Nr. 227. S. 910; Preuss, Staatszeitung, Nrs. 335. 339 u. 346; Mérian; Ann. de Chim. et de Phys. t. xlv. p. 402; Colla, Giorn. Astron. 1833; Studer.
—— —— End of the month.	About Vesuvius	Subterranean disturbances on several days.	....	Accompanied by very little eruption	Dorfzeitung, Nr. 227. S. 910.
—— Dec. 2. 0^h 15^m A.M.	In the mine "Neue Hoffnung Gottes" at St. Blaise in Baden.	Another strong vibratory shock.	....	The windows of the building attached to the mine rattled, and the whole building itself seemed to shake. The miners fled in alarm from the mine.	Preuss, Staatszeitung, Nr. 346. S. 2690; Mérian.
—— —— 3. After 8 A.M.	Innsbruck in the Tyrol..	A shock from N.W. to S.E. Lasted six seconds, with constant intensity.	....	Accompanied by a rattling noise like the breaking of glass. Articles of furniture and glasses were set in motion. The sky was clear, but the lower part of the atmosphere cloudy. Wind S.E., slight.	Preuss, Staatszeitung, Nr. 347. S. 2697; Colla, Giorn. Astron. 1833, p. 75.
—— —— 8.	Near Rehhausen and Geustädt (near Naumburg).	Vibratory shocks......	....	....	Dorfzeitung, 1831, Nr. 3. S. 11.

1830. Dec. 28. About 2 P.M.	Coblentz and Neuwied, and the surrounding country.	A shock from N. (N.W.?) to S.E. At Rübenach, six or eight seconds after the explosion there heard, a quick strong shock.	....	At Rübenach, at the time mentioned, there arose a violent storm, which, however, only lasted a few minutes, and was followed by a loud explosion as of a piece of heavy ordnance. Two days before, the wells at Bubenheim (1½ mile from Coblentz, and ½ mile from Rübenach) suddenly dried up. On the 26th, at 2 A.M., the river Douro in Portugal, between Roa and Aranda, suddenly lost all its water, which did not return until 10 A.M. A short time before or after this event, quite the same thing happened to the river Alba de Tormes.	Preuss, Staatszeitung, 1831, Nr. 6, Beil. S. 48, Nr. 41. S. 344; Gothaische Zeitung, 1831, Nr. 5.
—— 29.	Sulmona and some other places in the Abruzzo, Italy.	Violent shocks	....	....	Preuss, Staatszeitung, 1831, Nr. 26, Beil. S. 219.
—	In the island of Amboyna, one of the Moluccas.	A violent earthquake..	....	....	Berghaus' Almanach für Freunde der Erdkunde, 1837, S. 224.
1831. Jan. 2. 3 P.M.	Lago-Negro in the Basilicata, kingdom of Naples.	An earthquake of 20 seconds' duration.	....	Ten houses and a neighbouring church fell	Preuss, Staatszeitung, 1831, Nr. 26. S. 219, Nr. 43, Beil. S. 359.
——— (At the same hour?.)	Cajeta in Calabria Citra	A severe shock	....	Buildings were injured, and masses of rock detached.	Ditto.
—— 15. N.S.	In the government of Nertschinsk in Siberia.	A slight earthquake, lasting about ten seconds. The shock was directed towards the N.E., and was more violent on the N.E. than any other side.	....	Accompanied by noise like thunder	Ditto, Nr. 112. S. 839.
—— 18.	Messina	Several shocks	....	....	Garnier, Météor. p. 96; Colla.
—— 28.	Ditto. Also on this day at Palermo.	Ditto. At Palermo one shock.	....	....	Ditto; Poggendorff's Annalen, B. xxiv. S. 54.
—— 29. Between 10 and 11 P.M.	In the arrondissements of Remiremont and St. Dié, department Vosges.	A severe shock from S.W. to N.E.	....	At Géraromer the shock was accompanied by a dull but distinct noise.	Moniteur, 15 Fév.
— Feb. 9.	Palermo	Another shock	....	....	Garnier, Météor. p. 96; Colla; Poggendorff's Annalen, B. xxiv. S. 54.

1.	2.	3.	4.	5.	6.
1831. Feb. 10.	Messina. The centre of disturbance seemed to be at Melazzo (twenty miles to the N.).	More shocks. At Melazzo more than sixty were reckoned.	....	From the 19th to the 25th the upper crater of Etna was in eruption, after which these shocks diminished in number, but did not cease until after the eruption in the island of Pantettaria in the month of July.	Garnier, Météor. p. 96; Pogg. Ann. B. xxiv. S. 54; Preuss, Staatszeitung, Nr. 163. S. 1052.
—— —— 22.	Aleppo............	A violent earthquake.	....	....	Dorfzeitung, 1831, Nr. 65.
—— Mar. 1. 11 P.M.	Ardvoirlich, Killin, and Tyndrum, in Perthshire, Scotland.	A shock which came from the N.W.	....	Accompanied by a sound resembling a sudden gust of wind. Doors and windows were shaken. The night was calm and frosty. The barometer was low; at Inverness the mean height for February was 29·10, the lowest monthly average for the year.	D. Milne's Catalogue of British Earthquakes, *loc. cit.*
—— —— 2. 8 P.M.	Dover, Ramsgate, Margate, and Deal, on S.E. coast of England.	A severe shock	....	....	Preuss, Staatszeitung, Nr. 73, Beil. S. 610; Journ. des Débats, 7 Mars; Férussac, Bull. des Sc. Phys. et Math. Août 1831.
—— —— 17.	In the island of Bardsey off the S.W. coast of Caernarvonshire.	A shock of an earthquake.	....	The shock was felt in the lighthouse on the island, and "set the whole building in quick vibration, and filled every one on the island with indescribable alarm." A similar shock had been felt in Bardsey about seventy years before.	J. H. Bransby in the Christian Reformer, vol. xviii. p. 504.
—— —— 26. 11h 25m A.M.	San Remo in Pignerol (Piedmont).	Severe vertical shocks and more prolonged oscillations, together lasting fourteen seconds.	....	Preceded by subterranean noise like the rattling of carriages. A thick mist (cloud of dust?) rose above the roofs of the shaken buildings.	Alb. Nota, del Tremuoto Avvenuto nella citta e provincia di S. Reno l'anno 1831. Pignerolo, 8vo. 46 p.
—— —— 28.	Taggia and Castellaro in Pignerol (Piedmont).	A severe vibratory shock.	....	Fifty-two houses were thrown down, many others injured, and a bridge cracked. On the plain, and on the western side of the hill fissures opened in the earth.	Ditto.
—— —— ...	In Sicily	Shocks............	....	The town of Melazzo was ruined	Huot, Géologie, p. 117.
—— April 2.	Cariati in Calabria Citra	A shock, followed by several others.	....	....	Gothaische Zeitung, 1831, Nr. 86.
—— —— Before the 3rd (when the account was written).	In the southern part of the island of Samos.	Violent shocks.........	....	Followed by the fall of one of the highest mountains opposite Icaria. An enormous mass of water burst forth from the mountain and carried everything before it on its way to the sea. The Constitutionnel of 6 Juillet gives the date	Preuss, Staatszeitung, Nr. 160. S. 1040.

				of this event as May 7, and the same journal for 10th September says that a violent earthquake had been felt in the island of Scio.	
1831. April 12. Noon.	At sea, in 0° 22′ S. lat., and 23° 27′ W. long.		On board the ship 'l'Aigle,' Capt. J. Taylor, a shock was felt exactly as if the vessel had touched upon a rock.	The rudder was greatly agitated, and a dull sound was heard beneath the water. The weather was fine, and the sea calm.	Daussy in the Comptes Rendus de l'Acad. t. vi. p. 514.
— — —	Cariati in Calabria Citra	Another shock, much more severe than that of the 2nd. Others succeeded it daily up to the 22nd.			Gothaische Zeitung, Nr. 86.
— — 29. About 5 P.M.	Orleans in France and the neighbourhood.	Several rather severe shocks.			Journ. des Débats, 3 Mai.
— May 26. $11^h 18^m$ A.M. At Marseilles at $11^h 15^m$.	Genoa, and Porto-Mauricio on the Genoese coast (about twenty-seven miles from Monte Negro). Also felt at Marseilles.	Violent shocks, some of them vertical, and some in a side direction, which succeeded each other within two seconds, and seemed to come from the side of Monte Negro (*i. e.* E. to W.).		Buildings were thrown down at Castellaro, and Caggia and Bussano also suffered severely.	Gothaische Zeitung, Nr. 101; Journ. des Débats, 8 Juin; Férussac, Bull. des Sc. Nat. t. xxvi. p. 152.
— — 28. $0^h 45^m$ or $1^h 30^m$ P.M.	Ditto. Not reported as having been felt at Marseilles. Particularly severe at Vintimiglia and Albenga.	Another shock. The motion seemed to be at once horizontal, vertical, and oblique.			Ditto.
— — Day not given. At night.	Odessa	Several shocks, of which one was very violent. Others during the course of the month.			Constitutionnel, 8 Sept.
— June 28. 5 P.M.	In Sicily, especially at Sciacca. Also felt at Palermo.	Very severe shocks, followed by others up to the 11th of	Several shocks were felt this day on board the ship	Followed, in July and the beginning of August, by a violent submarine eruption, and the upheaval of a new island between Sciacca and	Moniteur, 1 Sept., 2 et 28 Oct., 10 Nov.; Garnier, Météor. p. 95; v. Hoff.

1.	2.	3.	4.	5.	6.
		July.	'Britannia,' Admiral Malcolm, over the place where the new island afterwards appeared.	the island of Pantellaria. For a detailed account of this phænomenon, vide v. Hoff.	
1831. July 2.	In Sicily, especially at Palermo.	The shocks were very intense at Palermo on this day.	......	......	Moniteur, 1 Sept. 2 et 28 Oct., 10 Nov.; Garnier, Météor. p. 95; v. Hoff.
—— —— 13.	Parma	Several shocks	......	......	Colla.
—— —— 14.	Ditto	Ditto	......	......	Ditto.
—— —— ...	Murray Bay in the Gulf of St. Lawrence, Canada. Felt also at Beauport, ninety miles to the south-west, and other places in the vicinity.	Very many shocks. When the preceding noise appeared to have reached the house (of an observer) a heavy shock was felt, like a sudden blow, succeeded immediately by a rocking motion.	Also felt on board ships in Murray Bay.	Preceded by subterranean noise, which seemed to come from the north (or north-west). The rocking motion produced a feeling of sickness. Chimnies were thrown down and walls injured. Shocks are said to be of rather common occurrence in this district.	Trans. Geol. Soc. (Lond.) 2nd Series, vol. v. p. 98 (note); Trans. Soc. Quebec, vol. ii. p. 83. 89. 1831.
—— Aug. 3.	Bucharest, Ismail, Kischinew, and Leowo, Wallachia.	Shocks......	......	......	Preuss, Staatszeitung, Nr. 247. S. 1398.
—— —— 11.	Bridgetown in Barbadoes, and in Jamaica.	Ditto	......	During a violent hurricane which raged over the West Indies, especially Antigua, St. Vincent, Dominica, Guadeloupe, and Barbadoes. It lasted from $2^h\ 30^m$ A.M. to 5 P.M. Barbadoes suffered at once from the hurricane, the earthquake, and a volcanic eruption. 3000 persons perished altogether.	Ditto, Nr. 295. S. 1598, Nr. 298. S. 1610; Garnier, Météor. p. 168.
—— —— 14.	Resina near Naples	A shock	......	During an eruption of Vesuvius	Audot, Roy. de Naples, p. 74.
—— —— 27. Midnight.	Besançon in the departm. Doubs. And at the same hour at Fribourg in Switzerland.	Two rather violent shocks, with an interval of ten seconds.	......	Each shock preceded by a dull explosive noise lasting two seconds. Doors, windows, and articles of furniture were shaken. The Preuss, Staatszeitung reports the event as during the night of August 26–27.	Garnier, Météorologie, p. 169; Mérian; Preuss, Staatszeitung Nr. 250. S. 1410.
—— Sept. 11. $7^h\ 15^m$ or	Parma, Reggio, Modena, Castel-Nuovo, and as	An earthquake at the same time at these	......	At Parma accompanied by a dull noise like thunder. All the houses shook, more than 400	Gothaische Zeitung, Nr. 188 u. 193; Constitutionnel, 3 et 5 Oct.;

30^m P.M.	far as Venice.	different places. At Parma violent shocks from N.E. to S.W., which lasted more than eight seconds (minutes according to another account). At Venice they lasted the same time, but the direction was E. to W. Followed by other shocks on the 12th and 13th.		chimnies fell, bells sounded of themselves, clocks were stopped, and the horses and dogs showed great alarm. At Reggio 200 chimnies were thrown down, and the Benizzi palace was in great part ruined. From the 10th the water in the wells of Parma had been troubled.	Colla.
1831. Sept. 30.	Palermo	A shock	....	On the 21st an eruption of Vesuvius had begun, which continued until the end of the month, and begun again on the 6th or 7th of October, lasted until the 15th of that month, and then gradually ceased.	Poggendorff's Annalen, B. xxiv. S. 54; v. Hoff.
—— Oct. 8. 9^h 30^m P.M.	Arica in Peru. Extended towards the south to the most distant extremity of the republic, and towards the north as far as Camana, (therefore over about 7° of lat.). Felt at Chuquisaca, 400 miles inland.	A violent vibratory shock, in a vertical direction, which lasted about seventy seconds. The motion proceeded from S. to N. This principal shock was followed at 11 P.M., and 5 A.M. the next morning, by others, and even as long after as February 7, 1832, a distinct trembling of the earth was felt. In the intermediate time ninety-seven shocks were reckoned.	Also felt at sea at the distance of a hundred miles from Arica. The ships in harbour experienced violent shocks.	Preceded by a subterranean hollow rolling noise like distant thunder, but louder. It lasted about ten seconds. Many houses were thrown down, and others injured, the walls cracked, &c. The shocks of later date were unaccompanied by noise. (According to another account scarcely a stone was left upon another in Arica, and a village fifteen leagues to the south was also totally destroyed, but one lying to the north of Arica, although nearer, suffered less.) No earthquake of any consequence had been felt in this region for nearly a century.	Edinburgh New Phil. Journal, April and July 1834; Das Ausland, 1831. Nr. 110. S. 440.
—— —— 16.	In the Romagna, Italy...	Shocks	....	....	Antologia di Firenze, 1832, Jun. p. 213.

1.	2.	3.	4.	5.	6.
1831. Oct. 27 to Nov. 7.	Foligno in the States of the Church.	Daily shocks during this period. The most violent were on the 7th of November.		Many houses thrown down	Journ. des Débats, 2 Déc.; Garnier, Météorologie, p. 109.
—— Nov. 17. 6h 15m A.M.	Swärdsjo near Fahlun in Sweden.	A shock from S. to N.		During a violent storm from the north. The shock was accompanied by a loud explosive noise, which was heard also in the villages of Mornäo and Zenger, and at Fahlun. An extraordinary light appeared in the northern horizon.	Preuss, Staatszeitung, Nr. 351. S. 1825.
—— —— 19. In the evening.	Neufchâtel and Fribourg			Perhaps this account only refers to the events of the 20th and 22nd, wrongly reported as to date.	M. Studer's Catalogue.
—— —— 20. 10 P.M.	Val-de-Travers, Locles, and Neufchâtel	Two slight shocks			Journ. des Débats, 1 Déc.; Constitutionnel, 19 Déc.
—— —— 22. 9h 55m P.M.	Fribourg in Switzerland				Mérian.
—— —— 29. 9h 30m P.M.	In and about the Thüringerwald, in the district of the sources of the Werra and Schleusse. Most strongly felt in the higher mountain regions of the Thüringerwald, at Trauenwald, Schmiedefeld, and Neustadt; to the north in the bailiwick of Gehren and Katzhütte; and on the south along the course of the Werra to Eisfeld and Hilburghausen.	A severe vibratory shock, strong enough to make the houses quiver. Three separate vibrations are said to have been felt, of which the second only was attended with noise.		Accompanied by a very loud rolling noise passing from S. to N., and lasting five or six seconds. On the day of the earthquake, before and after the shocks, and on the day before, a calm prevailed, but the preceding days had been stormy. The Werra was unusually high. According to some accounts, a fireball, apparently as large as the moon, was seen passing towards the west.	Dorfzeitung, Nr. 224. S. 906, Nr. 227. S. 917, Nr. 229. S. 927.
—— —— —	Neufchâtel				Ditto, Nr. 231, S. 934.
—— —— 30.	In Chili	Shocks			Perrey's Memoir on Earthquakes in the basin of the Rhine, p. 91.

1831. Nov. ...	Fornovo, fourteen miles from Parma.	Slight shocks during a period of several days.	....	....	Colla.
—— Dec. 3. 7h 50m P.M.	In the island of Trinidad. Also felt in St. Christopher's.	A violent earthquake. In Trinidad the first shock lasted nearly three seconds, and was followed by an oscillation perceptible for four to six seconds. After the noise which succeeded this, the second shock occurred, which was much more terrible than the first. At 10 P.M., and at 2 A.M. the next morning, shocks were also felt, but of nothing like the violence of the first.	The sea was in a state of violent agitation, and on board ship the shocks were felt as well as on land.	Followed by a noise like distant thunder. When the second shock occurred the earth seemed to rise and fall like the waves of the sea, and the strongest as well as the slightest buildings quivered to the ground. In the early part of the evening the heat was unbearable, and during the earthquake there was not a breath of wind stirring. Some heavy showers of rain followed.	Ausland, 1832, Nr. 110. S. 440, quoting a journal of Trinidad of the 7th Dec. 1831; Monthly Magazine, 1832, April, p. 169; Leonhard u. Bronn, N. Jahrbuch für Mineralogie, 1833, S. 127.
—— —— 4. 2h 30m (Italian time).	In Piedmont, at Caggia (Taggia?) and Castellaro and in the neighbourhood, where shocks were felt on the 28th of March. The valley separating these two places seemed to be the centre of disturbance.	More shocks	....	....	Alb. Nota del Tremuoto Avvenuto nella citta e provincia di S. Remo, l'anno 1831.
—— —— 22.	Mount Vesuvius	Violent tremblings ...	....	Accompanied by loud detonations	Allgemeine Zeitung, 1832, Nr. 17, Beil. S. 65, Nr. 33, Beil. S. 132.
—— —— 24. In the evening.	Ditto	Another, very violent	....	Five fissures opened, from which the lava flowed on the morning of the 25th, and continued to flow until January 9, 1832.	Ditto.

1.	2.	3.	4.	5.	6.
1831. Dec. 25. 9 P.M.	Lohugbat in Kemaon, in the N.E. of Hindostan; on the southern slope of the western spur of the Himalaya.	An undulatory motion of the earth from N.W. to S.E., lasting seven seconds.			Berliner Spenersche Zeitung, 1837, Nr. 59.
1832. Jan. 1. In one of the earliest hours of the morning.	Resina at the foot of Vesuvius.	An earthquake			Allgemeine Zeitung, Nr. 33, Beil. S. 132.
—— —— 13. After 2 P.M. at Foligno.	Foligno, Bevagna, Perugia, Assisi, Spello, Montefalco, Canara, and in Rome. Most violent at the two first named places. Extended along a line parallel to the Apennines. Felt at Parma.	At Foligno a terrible shock, followed an hour after by a second. At Bevagna the first shock lasted eleven seconds, and was followed by five others. At Rome the shocks were undulatory, and not severe. They recurred at 3 P.M., and at 2 A.M. the following morning. At Foligno the shocks continued at intervals up to the 15th. During the night of 13 to 14, there were 38.		Preceded and followed at Foligno by violent rain mixed with hail. A man going to draw water found the well filled to the brim, and the furrows in the fields full of muddy water (from the rain?). A few minutes after, he felt the first shock. On returning soon after to the well, he found it quite dry; the water also had disappeared from the fields, in which deep cracks were to be seen. Near Bevagna much resinous and sulphurous matter was said to have come out of the earth. Here and at several other places buildings were injured.	Allgemeine Zeitung, Nr. 24. S. 94, Nr. 26. S. 102, Nr. 42. S. 165; Ausland, Nr. 81. S. 324, Nr. 110, S. 440; Journ. des Débats, 31 Janv.; Constitutionnel, 30 et 31 Janv.; Colla.
—— —— Night between 17 & 18.	Rome	Another vibratory shock.			Allgemeine Zeitung, Nr. 33, Beil. S. 131.
—— —— 27.	Foligno	Another slight shock		Preceded by a detonation in the air	Constitutionnel, 25 Fév.
—— —— 29.	Trevi, six miles from Foligno.	A shock		Caused much damage	Ausland, Nr. 110. S. 440.
—— Feb. 1. About noon and 10 P.M.	In the Haute Engadine, Switzerland.	Shocks at the hours mentioned.			Mérian.

1832. Feb. 16. 4 A.M.	Sciacca in Sicily	A slight shock		At the same time vapour was seen to rise from the sea in the same place where the new island had made its appearance in the preceding July. On this day Vesuvius, which had remained quiet since the beginning of the year, began to send forth smoke, and on the 20th an eruption of stones, lava, &c. commenced, which continued more or less (with slight tremblings) up to the end of March, and slightly till the end of July, when a great eruption occurred.	Froriep's Notizen, B. xxxiii. Nr. 15. S. 231, Nr. 21. S. 324; v. Hoff.
—— —— 21.	Pozzuoli near Vesuvius	Slight shocks			Ditto; Audot, Roy. de Naples, p. 74.
—— —— ...	In Umbria	Constant oscillations during the whole month.			Allgemeine Zeitung, Nr. 52, Beil. S. 297.
—— —— ...	Lahore, the valley of Badakhshan, and other parts of North-western India.			Huge masses of rock were thrown down in many places from the cliffs.	Trans. Geol. Soc. (London) 2nd series, vol. iii. pp. 492. 494.
—— March 8. After 7 P.M.	In Calabria Ulteriore and a small part of Calabria Citeriore. Principally on the east of the Apennines, at S. Severino, Cotrone, Isola, Cutro, Policastro, Catanzaro, Roccabernardo, Roccadineto, Scandale, S. Mauro, Castello, and Ciro; also slightly in some places to the west of the mountains, especially at Monteleone and Reggio. In Calabria Citeriore the earthquake was felt at Cosenza. At Naples two or three slight shocks were felt.	A violent and destructive earthquake. The first, vibratory, shock was the most violent, in the direction S.E. to N.W., and lasted 11 seconds. The shocks recurred not only during the following night, but more slightly up to the 16th.		Cutro was completely destroyed, and great damage done in other places, especially at Soveria in the district of Catanzaro. On the 7th a luminous meteor was observed at Potenza, which lasted nearly a minute, and was followed by an explosion like that of a cannon.	Allgemeine Zeitung, Nr. 86, Beil. S. 343, Nr. 87. S. 347, Nr. 99, Beil. S. 393, Nr. 100, Beil. S. 397; Audot, Roy. de Naples, p. 74; Constitutionnel, 24 Mars, 18 Avril.

1.	2.	3.	4.	5.	6.
1832. Mar. 11, 12, 13, 14, and 15.	Assise, La Bastia, La Cannara, Catanzaro, Cotrone, Monte-Leone, Reggio, Milan, Mantua, Verona, Reggio (in Modena), Genoa, and Parma.	Violent and repeated shocks. At Milan, Mantua, Verona, Reggio, and Genoa, they were felt from the 11th to the 13th, and at Parma daily from the 11th to the 17th. At the latter place they were in the direction of the magnetic meridian. At Giornico, Bellinzone, and Lugano, on the 13th, after 3 P.M.		La Bastia and La Cannara were completely ruined, and at many other places great damage was done. At the time of the shocks of the 14th and 15th the waters of the lake of Dsirma in Russia were extraordinarily disturbed, and a noise was heard like that of a storm.	Journ. des Débats, 3 et 29 Avril; Constitutionnel, 28 Mars, 2 et 18 Avril, 2 Mai; Colla; Allgemeine Zeitung, Nr. 86, Beil. S. 343, Nr. 91, Beil. S. 362; Antologia, 1832, Jun. p. 311; Communication of M. Mérian to M. Perrey.
—— —— 19.	Parma	More shocks			Ditto.
—— —— 21.	Ditto	Ditto			Ditto.
—— —— 22.	Reggio in Calabria	Diastrous shocks		The ducal palace was violently shaken	Ditto.
—— —— 28.	Parma	More shocks			Ditto.
—— —— 31. 7 A.M.	Irkutsk in Siberia	A rather severe earthquake. The first shock lasted nearly a minute, and was scarcely perceptible, but the second, which occurred 4 minutes later, made everything in the houses shake violently.		Neither of the shocks was accompanied by any subterranean noise.	Constitutionnel, 22 Juin.
—— April. { Beginning of the month.	Catanzaro in Calabria	More shocks, of great violence.		New ruins produced	Authorities for March 11.
—— —— 11. 8 A.M.	Kiachta in Siberia	A rather severe shock, lasting 45 seconds.			Moniteur, 3 Sept.
—— —— 12.	Parma	Several shocks			Authorities for March 11.

1832. Apr. 14. (N. S.) 3 A.M.	Tiflis in Georgia	Two distinct shocks, followed by others at 4^h 52^m A.M. and at 3^h and 3^h 10^m P.M.	....	Accompanied by a noise as if the houses were falling. M. Vichmann observed three shocks at Tiflis in 1832–33.	Memoir on Earthquakes in the Caucasus, by M. Philadelphine, Professor of Physics at Tiflis, translated by M. Kuppfer; Dubois de Montpéreux, Voyage autour du Caucase, t. iii. p. 271.
—— —— 19.	Parma	Several shocks	....	....	Authorities for March 11.
—— —— 22.	Ditto	Ditto	....	....	Ditto.
—— In the middle of the year.	In Nova Scotia	A slight shock........	....	....	Galignani's Messenger, 16th Oct., quoting from a series of Montreal journals, the date of the last of which was 13th Sept.
—— July 2. 11 P.M.	Lohugbat in Kemaon, Hindostan.	The earth shook for 12 secs.	....	Accompanied by a sound like that of rushing water, which lasted three seconds before the shock, and as long after it.	Berliner Spenersche Zeitung, 1837, Nr. 59.
—— —— 20. 6 A.M.	Lisbon	A severe shock, lasting about 10 secs.	....	Cracks appeared in some of the walls, and people were violently shaken in their beds. On the morning of the 15th of this month an extraordinary flux and reflux of the sea was observed at Dantzig, supposed by some to be caused by an earthquake. On the 23rd a tremendous eruption of Vesuvius began, which did not cease until the 16th August, and was followed on the 16th September by another of less energy.	Allgemeine Zeitung, Nr. 221. S. 881; Dorfzeitung, Nr. 111. S. 562; v. Hoff.
—— —— ...	Cotrone in Calabria ...	Repeated shocks	....	....	Allgemeine Zeitung, ausserord. Beil. Nr. 345. S. 1379.
—— Aug. 2.	Tiflis in Georgia	....	....	....	Plieninger, Jahrsbericht über die Witterungs-Verhältnisse in Würtemberg.
—— —— 7 and 10.	Vesuvius and the neighbourhood.	Severe and frequent shocks, particularly on these two days.	....	Accompanying the violent eruption of the volcano, which still continued. Remarkable atmospheric disturbances.	Journ. des Débats, 2 Sept. Bibl. Univ. Avril 1833, p. 350; Archives des Découv. 1832, p. 244; v. Hoff.
—— —— 18. 7 A.M.	Lohugbat in Kemaon, Hindostan.	Another vibratory shock, of 5 secs. duration.	....	The weather was hot and sultry	Berliner Spenersche Zeitung, 1837, Nr. 59.
—— —— 31. About 1^h 45^m A.M.	Langhiramo, Castrignano, and neighbourhood; in Italy (what State?). Also felt at Berceto.	Slight shocks, more severe at Monchio-di-Sasso, Campora, and Scurano.	....	....	Colla.

1.	2.	3.	4.	5.	6.
1832. Sept. Night between 3 and 4.	Poitiers in France	A rather severe shock, lasting some secs.			Moniteur, 9 Sept.
—— —— 23. 10 P.M.	Lohugbat in Kemaon, Hindostan.	Another earthquake, as on the 2nd July.			Berliner Spenersche Zeitung, 1837, Nr. 59.
—— Oct. 18 or 19. 2 P.M.	In many parts of the kingdom of Saxony, especially in the districts on the Pleisse and Mulde to the Elbe near Dessau. Most distinctly felt at Gross-Hermsdorf in the bailiwick of Borna, west of the Pleisse, and at the quarries of Rochlitz in the valley of the Zwickau Mulde.	A vibratory shock. At Dessau it was like the explosion of a mass of powder.		At Gross-Hermsdorf and the quarries of Rochlitz, accompanied by loud subterranean thunder. The upper mist in the air suddenly disappeared after the earthquake, and the air became mild.	Allgemeine Zeitung, ausserord. Beil. Nr. 464. S. 1855; Leipziger Zeitung, Nr. 256; Kastner's Archiv, B. vi. S. 301 u. 309.
—— —— 31.	On and around Etna	Several slight shocks.		In the forests of Aderno di Bronte and Maletto the shocks were so severe that houses were injured. On this day a great eruption of Etna, the first since 1819, began, which did not cease until December.	Leonhard u. Bronn, N. Jahrbuch, 1833. S. 641.
—— Nov. 5.	Ditto. Felt even at Catania.	The earth trembled violently.		Accompanied by tremendous explosions, and a revival of the eruption.	Ditto.
—— —— 13.	Zeiz in Saxony	A vibratory shock		In Dessau, on the evening of this day, there was a thick yellowish fog with a perceptible odour.	Kastner's Archiv, B. vi. S. 309.
—— —— 24. 10h 30m A.M.	On and around Etna	A terrible shock. Ten minutes after there followed another, of less violence.		Accompanied by tremendous explosions. At Nicolosi great damage was done. Preceded and followed by heavy rain. Garnier gives the date *Dec.* 24.	Leonhard u. Bronn, N. Jahrbuch, 1833, S. 641.
—— —— 25.	Ditto	Another shock. In the little village of Milo, 18 miles from Catania, severe shocks were felt daily up to the 29th.		Accompanied by subterranean noise as before. A tower, before injured by the earthquake of 1818, was so severely shaken, that three days afterwards it fell.	Ditto.

1832. Nov. 29. 10 A.M.	Nischneitagilsk in the Oural. Most violent in the district of the platina washings.	An earthquake. The motion appeared to go from S.W. to N.E., or nearly parallel to the chain of the Oural.		Accompanied at the platina washings by loud noise like thunder, which lasted several seconds. A violent storm at the same time.	Gothaische Zeitung, 1833, Nr. 43.
—— —— Day not given. 11 P.M.	At sea, in 0° 22′ S. lat., and 21° 15′ W. long. (from Paris).		On board the ship 'La Seine,' Captain Le Marié, a shock was felt, so severe that it was supposed that the vessel had touched upon a shoal.		Daussy in the Comptes Rendus de l'Acad. t. vi. p. 514.
—— Dec. 6.	In Bessarabia				Plieninger, Jahrsbericht über die Witterungs-Verhältnisse in Würtemberg.
—— —— 10.	Ditto				Ditto.
—— —— 14.	In Saxony				Ditto.
—— —— 17. 9 P.M.	Compiano in the duchy of Parma, and the neighbourhood.	Two perceptible shocks, followed by a third about midnight.			Colla.
—— —— 18. 4 or 5 A.M.	Ditto	Three more shocks, one of which was severe and of long duration.		No damage done. On the 16th an eruption of Vesuvius began, which continued until the 24th.	Ditto; v. Hoff.
—— —— 30. 8^h 20^m P.M.	Swansea in S. Wales	Four shocks, from S.W. by W. to N.E. by E. Altogether lasted a second and a half.		Preceded by a noise like the distant firing of heavy artillery. This sound was heard two or three seconds before the shock.	Gentleman's Magazine, vol. cii. pt. 2. p. 640.
—— —— 31. In the morning.	Swansea, Neath, Llandovery, Caermarthen, and other places in S. Wales; and at Castlebridge, Co. Wexford, Ireland.			Can this account refer to a different event from the one last recorded?	The Spectator, No. 237. Jan. 12, 1833.
——	Huasco in Chili, South America.				Phil. Trans. 1836, p. 21.
1833. Jan. 5. Before 11 P.M.	Soleure in Switzerland.				Mérian.

1.	2.	3.	4.	5.	6.
1833. Jan. 11. $1^h 50^m$ A.M.	Laybach in Carinthia ...	Two violent shocks, lasting two seconds and a half.	....	....	Garnier, Météorologie, p. 170.
—— 13.	Linköping in Sweden ...	Two shocks, which lasted about 10 seconds.	....	The following night, near the bridge of Montala, the water of the river ceased to flow and was raised up into a kind of sea. The bed of the river could be passed dryshod, although in general 60,000 tons of water pass under this bridge per minute. The phænomenon was supposed to be connected with the earthquake.	Ditto.
—— 14. Between $10^h 30^m$ and $10^h 45^m$ A.M.	In Saxony (in the original erroneously Switzerland), at Machern, Brandis, Puchace, and other adjoining villages in the neighbourhood of Leipzig.	An earthquake, which consisted of a severe shock from S. to S.W. (?), lasting nearly 2 seconds.	....	The shock was accompanied by a dull explosion like a blast in a stone quarry, followed by a rolling as of distant thunder, or like the noise of a carriage.	Ditto, p. 171.
— Feb. 5. Some minutes past 5 A.M.	Noirmoutiers in the départm. Charente.	Two shocks. The first was the most severe, and lasted 6 or 7 seconds. It was followed 7 or 8 seconds later by the second.	The second shock, reacting on the sea, communicated a perceptible motion to the vessels.	The first shock was taken for the passage of a carriage on the pavement. The subterranean noise passed from S. to N.	Ditto; Journ. des Débats, 13 Fév.
—— 7. $0^h 30^m$ A.M.	In the West Indies	A slight shock	....	....	L'Institut, 29 Juin; Garnier, p. 172.
—— 8. 12 at night.	Island of Antigua	Lasted nearly 30 secs.	....	In all probability this refers to the same event as that last mentioned.	Annual Register, 1833, p. 71.
—— 10. $8^h 45^m$ P.M.	In the West Indies	A moderate shock ...	....	....	L'Institut, 29 Juin; Garnier, p. 172.
—— 14. $2^h 30^m$ A.M.	Ditto	Two severe shocks ...	....	....	Ditto.
—— 27. $3^h 28^m$ A.M.	Friedrichshafen on the Lake of Constance, and neighbourhood. Also ($3^h 30^m$) at Biberach, Schneeberg,	A shock	....	Accompanied by a rolling noise	Mérian; Plieninger, Jahrsbericht über die Witterungs-Verhältnisse in Würtemberg.

	and Weingarten (in Würtemberg?).				
1833. Mar. 20.	Glengarry, Inverness-shire.			The door of an inn was lifted off the latch	D. Milne's Catalogue of British Earthquakes, *loc. cit.*
—— —— 23. $10^h\ 30^m$ P.M.	In the West Indies	Another shock			L'Institut, 29 Juin; Garnier, p. 172.
—— —— 24. $9^h\ 15^m$ P.M.	Parma	A slight undulatory shock from S.E. to N.W., followed, 7 minutes after, by a second, in the same direction and lasting 4 secs.		The atmosphere was calm, and the sky obscured by clouds, some of which were very much elongated. A gust of wind of considerable force had preceded the shock by a few minutes, and caused the thermometer to rise 1° R.	Colla.
—— —— and April.	Murray Bay and other places on the shores of the Gulf of St. Lawrence.	Very many shocks during these two months.			Trans. Geol. Soc. (London) 2nd series, vol. v. p. 98, note.
—— April. About the 2nd (taken from a London letter of the 10th), $8^h\ 15^m$ P.M.	Horsham in Sussex	A shock of earthquake		More perceptible in some houses than in others. Some persons were greatly frightened, while others felt nothing.	Garnier, p. 171.
—— —— 4. $4^h\ 18^m$ A.M.	Vicenza in Italy	A severe shock, preceded at about $1^h\ 15^m$ by a slighter one. Both were undulatory.		The bell of the great tower sounded of itself	Ditto.
—— —— 6. About $10^h\ 30^m$ P.M.	At Algiers	A shock which lasted three seconds.			Ditto.
—— —— 7. 3 A.M.	Ditto	Another shock, stronger than the last.			Ditto.
—— —— 15. $9^h\ 45^m$ P.M.	In the West Indies. The island of St. Christopher's is specified.	Rather a severe shock. Lasted some seconds, and was followed by several others of less violence.			L'Institut, 29 Juin; Garnier, p. 172; Annual Register, 1833, p. 71.

1.	2.	3.	4.	5.	6.
1833. Apr. 17. 0h 30m A.M.	Carthagena, Orihuela, Almoradi, and Torrevieja in Spain, and at some points of the coast of Africa, opposite to Carthagena.	Three rather severe vibratory shocks.	....	In Murcia, especially at Torrevieja and Almoradi, earthquake shocks had not ceased to be occasionally felt since 1829.	Garnier, p. 172.
—— —— 25. About 10h 30m A.M.	Huasco in the province of Coquimbo, Chili, between the 28th and 29th degrees of S. lat.	A violent earthquake. A second shock followed, but after what interval is not said.	....	A large part of the houses in this district were thrown down, and the rest greatly injured. The second shock completed the destruction of the church, which had been much injured by the first.	Ditto.
—— May 4. 11 P.M.	In the West Indies......	A slight shock, but of considerable duration.	....	Preceded by great drought	Ditto; L'Institut, 29 Juin.
—— —— 21. 2 P.M.	Frascati and Monte Pozzio in the environs of Rome.	A shock of earthquake	....	No damage done............	Garnier, p. 172.
—— June 11.	North of Manchester ...	....	....	....	D. Milne's Catalogue, *loc. cit.*
—— —— 22. 7 A.M.	Confreville, Caillot, Angerville, Bayeul, Saint-Maclou, Limpiville, and other communes in the canton of Goderville, arrondissement of Havre, departm. Seine-Inférieure.	Violent shocks, which lasted but a few seconds, alarmed the inhabitants.	....	....	Journ. des Débats, 2 Juillet; Garnier, p. 172.
—— July 5. 1h 10m A.M.	Parma	A slight undulatory shock, from E. to W.	....	....	Colla.
—— Aug. 12 and 13.	Vesuvius	Some shocks	....	Accompanying an eruption of the volcano	Journ. des Débats, 3 Sept.
—— —— 23. About noon.	Utrecht in Holland......	A slight shock.........	....	....	Garnier, p. 173.
—— —— 26. 5h 30m or 6 P.M., and again at 11 and 12, the latter being the most vio-	Calcutta, Agra, Lucknow, Tirhoot, Purneeah, Patna, Buxar, Allahabad, Monghyr, Katmandu, &c.; in fact all over the cen- [illegible]	A violent earthquake. At Calcutta there were three shocks, at Lucknow four, at Purneeah three, and at each of the other places men-	....	Water was in many places thrown out of the tanks, as at Tirhoot from a tank of 4 feet deep, in which the surface of the water was 3 feet below the edge. Birds were thrown out of their nests, cattle were greatly frightened, and men could scarcely keep their feet. At Buxar the shocks were felt with great violence on one	Asiatic Journal, N. S. vol. xiii. pt. 2. pp. 156 & 195.

lent. The time of the principal shock for several of the places was as follows, reducing to Calcutta time:— At Calcutta (the second shock), 11^h 34^m 48^s. At Katmandu, 10^h 57^m. At Rungpur, 11^h 18^m. At Monghyr, 11^h 34^m. At Arrah, 11^h 29^m. In the Rotas Hills, 11^h 30^m. At Gorackpur, 11^h 39^m. At Allahabad, 11^h 28^m. At Bankura (Rampoora?), 11^h 34^m.	India, especially in Nepaul. Also felt at Lassa.	tioned, several shocks of great violence, besides numerous slighter ones. The most violent were those at the hours mentioned, but the slighter ones continued to recur at intervals until the following October, some of the shocks during that time being rather severe. Each of the shocks lasted but a short time, generally 3 or 4 secs., but some are mentioned of a minute's duration. At Tirhoot the motion was from E. to W., at Buxar apparently from N. to S., at Patna apparently from E. to W., at Calcutta from N.E. to S.W., at Katmandu in Nepaul apparently from E. to W. All the shocks came from E. or N.E. At Katmandu the motion lasted about forty seconds. At Purneeah the direction is given as S. to E. At most of the places the earth		side of the river, and but very little on the other. Accompanied in many places by loud subterranean noises, especially at Katmandu, where the most violent shock (at 11 P.M.) was attended by a noise compared to that of 100 pieces of artillery. Here also (at Katmandu) the trees and even the smallest shrubs waved in the air from their very roots. Above 100 houses were levelled in a moment, and at other places still greater loss of buildings and life occurred. At Chupra a chasm opened in the earth of considerable length and depth. Preceded by very close and oppressive weather, and followed in several places by wind and rain.	

1.	2.	3.	4.	5.	6.
		was in almost continual agitation for twenty-four hours.			
1833. Sept. 18. 10 A.M.	Chichester, Birdham, and Liphook, in Dorsetshire.	The shock produced a tremor, followed by an undulation. To a person in an old cottage it resembled the sudden turning of a powerful steam-engine or thrashing machine. In solid buildings it was like the fall of a weighty body, followed by a prolonged undulation.	The shock was felt in a boat in Chichester harbour, as if it had struck a rock.	Preceded by the sound of a rushing wind. Barometer 29·25 in. The air was very sultry, warm, and still. Wind from S. and S.W. On the previous evening a brilliant aurora, with meteors falling. Pheasants crowed.	D. Milne's Catalogue, *loc. cit.*
———	Arica and Saena in Peru.	An earthquake	....	The danger was announced by the baying of dogs and braying of asses. The day before, the atmosphere had been frightfully still and stagnant. With the exception of some puffs of wind at rare intervals, *which were felt as well in the interior of apartments as without*, the air on the 18th was completely still at Saena. The shocks left a great number of empty bottles standing in the places which they had occupied, but their corks were found strewn on all sides upon the floor. None of the empty bottles were thrown down, but full ones, on the contrary, were thrown off their shelves and broken. The varnish on a new table recovered its fluidity so far that the next day the table was surrounded by viscid drops. A large part of the water contained in some jars buried in the ground was thrown out, although the surface of the water was 3 or 4 ft. below the rim of the jars. It was remarked that after a shock, whether great or slight, the dogs of the town proceeded to quench their thirst at the nearest pool.	Garnier, p. 173.

1833. Sept. 20.	Meerut in Bengal	The only remarkable shock since that of the 26th of August. Lasted about fifteen seconds.			Asiatic Journal, N. S. vol. xiii. pt. 2. p. 159.
—— Oct. 4. 7 or 8h 30m A.M.	Monghyr and Jionpoor in Bengal.	At Monghyr the shock was very violent and lasted a minute and a half. At Jionpoor it was sudden and smart, lasting only a few seconds.			Ditto, p. 241.
—— —— 9. 1h 15m P.M.	Issoire in the departm. Puy-de-Dôme.	Rather a severe shock.		Accompanied by noise. The weather, which before looked stormy, then cleared up.	Journ. des Débats, 15 et 26 Oct.; France Pittoresque, t. iii. p. 3.
—— —— 15.	Ditto	Several more shocks. They were frequent in Auvergne, at Cantal, and in the Haute-Loire, from the 8th to the 22nd. That of the 18th extended as far as Roanne.		Accompanied by an indistinct bellowing noise at Clermont, Issoire, and the neighbourhood. It was remarked that these shocks in Auvergne did not extend beyond the mountain chain of the Puy-de-Dôme, and that they had been preceded by two years of great drought.	Ditto; Annales de l'Auvergne, 1833.
—— —— 18. 4h 40m A.M.	Goruckpoor in Bengal	Very violent shock, apparently from E. to W. Lasted nearly a minute.			Asiatic Journal, N. S. vol. xiii. pt. 2. p. 241.
—— —— 24. 8h 35m P.M.	Singapore	First a slight shock, then a tremulous motion of the earth which lasted about a minute, and then two other shocks still slighter than the first.			Ditto, vol. xiv. pt. 2. p. 21.
—— Nov. 13. 2h 40m A.M.	Chichester in Dorsetshire.	The shock consisted of a number of undulations rapidly succeeding each other. Followed by another and much		Preceded by a distinct low sound. On the previous day there had been a thick fog, which came from the east and continued up to 9 A.M. on the 13th. This thick fog was said by an observer to be precisely similar to that which accompanied the Lisbon earthquakes of 1807	D. Milne's Catalogue of British Earthquakes, *loc. cit.*

1.	2.	3.	4.	5.	6.
		slighter shock about 6 A.M.		and 1816. The fog commenced on the 12th, succeeding heavy rain on the 11th of Nov. Numerous meteors were observed in North America at 3 A.M. on the 13th.	
1833. Nov 24. (*Oct.* 24?). At night.	Island of Java, and still more in Sumatra.	An earthquake	....	Great inundations produced by the overflowing of one of the rivers, as also a mountain lake, consequent on the earthquake. The volcano of Bocket Kaba in Sumatra reported to be in a state of activity.	Asiatic Journal, N. S. vol. xiv. pt. 2. p. 263.
—— Dec. 2. In the morning.	In the neighbourhood of Haarlem in Holland.	A shock of earthquake, which lasted twenty to twenty-five seconds.	....	....	Garnier, p. 173.
—— —— Night between 18 & 19.	In Bohemia..............	Some slight shocks *said* to have been felt.	....	During a terrible hurricane. A subterranean noise was said to have been heard.	Moniteur, 20 Janv. 1834.
1834. Jan. 3. Between 7 & 8 P.M.	Fort-Opus in Dalmatia..	Three great shocks, followed by several others the next day.	....	....	Journ. des Débats, 4 Fév.; Colla.
—— —— 4.	In the neighbourhood of Soleure, Switzerland.	A shock	....	....	M. Studer's Catalogue.
—— —— 6.	Ditto	Ditto	....	....	Ditto.
—— —— 7.	Ditto	Ditto	....	....	Ditto.
—— —— 8.	Ditto	Ditto	....	....	Ditto.
—— —— 13. $6^h\ 15^m$ P.M.	Parma and the environs.	Two slight shocks, lasting about three seconds. From S.E. to N.W.	....	....	Colla.
—— —— 20.	Sabiondoy near Pasto and Santiago in S. America.	....	....	....	Trans. Geol. Soc. (London) 2nd series, vol. v. p. 610.
—— —— 22. In the evening. In Martinique at 7^h 45^m P.M.	In the West Indies...... [illegible]	A shock producing an undulatory motion of the ground. [illegible]	....	In the night between the 21st and 22nd the town of Pasto in Upper Peru was completely destroyed by violent earthquakes. (This account doubtless refers to the event last recorded.) Santa Martha is said to have been destroyed by an earthquake, perhaps the same, and another at Pasto on the 1st of March is mentioned.	L'Institut, Nr. 54; Archives des Découv. 1834, p. 197; Moniteur, 4 et 6 Oct.

1834. Jan. 23. $2^h\ 45^m$ A.M.	Chichester and Longfleet near Poole in Dorsetshire. Felt also at Liphook, Farnhurst, Petworth, Pulborough, Bognor, Portsmouth, and Gosport. The centre of intensity supposed to be a few miles N.W. of Chichester.	A tremor was felt, which was followed by several undulatory movements with two-thirds of a second intervening betwixt each. The undulation at Stanstead House was from W. to E., and appeared to be single. At Pulborough three distinct shocks were felt in quick succession.		The shock was not felt on Portsdown Hill, but along the north and south sides. All the shocks were more severely felt at the lowest places. At Stanstead Hall a bed was lifted up. The barometer stood at 30 in., and had previously risen and fallen very capriciously, without any corresponding change of weather. The morning of the previous day was rainy, foggy, and warm. At the time of the shock the air was calm, but instantly after, the wind rose and blew strongly from S.W., with rain and lightning. The same humid weather prevailed up to the close of January, and the season was nearly a fortnight in advance up to the end of March. For ten weeks before the occurrence of the shock, 23rd of January 1834, the wind had pertinaciously prevailed from the S.W., and it had rained almost daily to a depth of nearly 12 inches (!).	D. Milne's Catalogue, *loc. cit.*; Moniteur, 4 Sept.
—— Feb. 2. $3^h\ 2^m$ A.M.	Œdelsberg in Carinthia. Felt simultaneously at Planina and the village of Salvina, about a mile from Œdelsberg.	A severe shock. The motion was rather oscillatory than undulatory. Direction = N. to S. Lasted twenty or thirty seconds.		Accompanied by a kind of subterranean bellowing noise.	Colla, Bibliot. Ital. t. 78.
—— —— — $8^h\ 45^m$ A.M.	Ditto. Also felt at Trieste.	Another shock, instantaneous, and very slight.			Ditto.
—— —— 12.	Lancaster in Pennsylvania, United States.	A shock which shook all the houses and extinguished the lights.		Compared by the inhabitants to the explosion of a powder mill.	Résumé des Trav. de la Soc. Géol. de France, an 1834; Bulletin, t. vi. p. 11.
—— —— 13. $1^h\ 30^m$ A.M.	Pontremoli in Tuscany..	A severe shock, with undulations and "soubresauts."		Some damage done	Journ. des Débats, 9 Mars; Colla; Gargiolli, Descrizione del tremuoto di Pontremoli; Annali di Statistica di Milano, vol. xl.
—— —— 14. Especially at $2^h\ 30^m$ P.M.	Ditto. The centre of disturbance seemed to be about Mt. Molinatico.	Many more shocks, eleven or twelve of which occurred at the hour mentioned.		At Pontremoli all the buildings were seriously injured, and in some villages five or six miles to the south, belfries, churches, and ill-built houses fell. Four persons perished beneath	Ditto.

1.	2.	3.	4.	5.	6.
		At Parma the direction was S.W. to N.E. The most severe of the shocks was first vertical, then horizontal from N.W. to S.E., and lasted twelve seconds. About 3^h two other violent shocks.		the ruins. The shocks at $2^h\ 30^m$ were preceded at Pontremoli by a very loud noise.	
1834. Feb. 15. About 8 (A.M.?).	Pontremoli in Tuscany..	A rather severe shock at Pontremoli. About $1^h\ 30^m$ and $9^h\ 30^m$ (P.M.?), at Parma, several others.	....	....	Journ. des Débats, 9 Mars; Colla; Gargiolli, Descrizione del tremuoto di Pontremoli; Annali di Statistica di Milano, vol. xl.
——— 16.	Ditto	Other slighter shocks at Pontremoli at intervals of three hours.	....	....	Ditto.
——— 17. A little after 5 P.M.	Ditto	A very severe shock. At Borgotaro at least forty (forty-four?) shocks were counted altogether. The first (at $2^h\ 30^m$ P.M.) was felt more or less throughout Upper Italy. Slight but frequent shocks occurred up to the end of the month in the territories of Pontremoli and Volterra.	....	The inhabitants fled from their houses. These shocks were always preceded or accompanied by dull explosions.	Ditto.
——— 20. 2 A.M.	Chichester in Dorsetshire.	A slight shock........	....	The report on these earthquakes at Chichester from which Mr. Milne has copied, observes that in May 1833 (though the previous spring had	D. Milne's Catalogue, *loc. cit.*

				been backward) vegetation had advanced more rapidly than usual. In the early part of September there was rain, during which the barometer fell nearly to 28 inches. The temperature of the ground had been unprecedentedly high for mid-winter, and the water in the wells 2° above the average.	
1834. Mar. 9.	At the mouth of the Kouban, at Anapa, and on the neighbouring part of the coast of the Black Sea.	An earthquake			Plieninger, Jahrsbericht über die Witterungs-Verhältnisse in Würtemberg.
—— 11. About 10ʰ 30ᵐ P.M.	Acapulco. Felt also at the same hour at Mexico.	At Acapulco a severe vertical shock, known in the country as "secousse de trepidation"; said to be of the usual kind. Followed by other shocks for several days in succession. At Mexico, an undulatory movement which lasted more than two minutes.	On the third day after this, the sea retired about thirty-three metres from the shore, and then returned *gradually* to its ordinary level.		Dupetit-Thouars, Voy. de la Vénus, t. ii. p. 213.
—— 21. 0ʰ 30ᵐ A.M.	Ranen in Helgeland	A severe shock, followed by a second at 3ʰ 30ᵐ P.M.		Walls were shaken, and doors slammed to. M. Keilhau supposes the day of the month to be wrongly reported.	Morgenblad, 1835, Nr. 661; Keilhau.
—— ...	In the neighbourhood of Pontremoli and Volterra, in Tuscany.	More shocks			Colla.
— April 13.	Gibraltar, Cadiz, and Algesiraz.	A slight shock			Ditto, Bibl. Ital. t. lxxviii.
—— 15 to 17.	In the district of Volterra, Tuscany, especially at Borgotaro.	Violent shocks		Accompanied by loud explosive noises	Colla.
— May 2. Noon.	Pontremoli in same district.	A violent shock			Ditto.

1.	2.	3.	4.	5.	6.
1834. May 6. 11 P.M.	Keni and Kischenew in Bessarabia.	A shock		Preceded by a loud noise at Kischenew	Colla, Bibl. Ital. t. lxxviii.
— — 8. 8 A.M.	Pontremoli in Tuscany.	Very perceptible shocks, followed by slighter ones.			Colla.
— —	Kischenew in Bessarabia.	Another shock			Plieninger, Jahrsbericht über die Witterungs-Verhältnisse in Würtemberg.
— — 16. 5h 25m P.M.	Borgotaro in Tuscany	A violent shock, with "soubresauts," lasting four or five seconds. At the same *physical* instant, a very slight shock at Parma.		Preceded by subterranean noise (rombo). The inhabitants fled out of the houses. The evening before, magnetic disturbances had been observed at Parma.	Colla.
— — 22, and three following days.	Santa Martha in S. America.	The first and most severe shock lasted three-quarters of a minute. Altogether sixty shocks during the four days.		The earth cracked in fissures which in many places were 6 inches wide, and from which hot and sulphurous vapour was ejected.	Annual Register, 1834, p. 71.
— — 23.	Jerusalem	A very severe shock		Some churches and other buildings were injured.	Colla.
— — 26.	Borgotaro in Tuscany	A slight shock			Ditto.
— June 6.	Ditto	A very perceptible shock.			Ditto.
— — 18.	In the island of Cephalonia.	Severe shocks		Some houses thrown down	Ditto.
— — 21. 0h 30m P.M.	Pontremoli in Tuscany	A severe shock			Ditto.
— July 4. 1h 45m A.M.	Parma, Milan, Genoa, and throughout Upper Italy.	At Parma a very perceptible undulatory shock, from S.W. to N.E., lasting more than ten seconds. At S. Vitale-de-Baganza (twelve miles S.W. of Parma) it was very violent and followed		At Milan a distinct hissing or whistling noise was heard in the air.	Ditto; Journ. des Débats, 13 Juillet.

		by several others. At Milan the motion was slight, undulatory, and from N.W. to S.E. Several more shocks were felt the next day.			
1834. July 4. (At same hour?.)	Brest in France	A very distinct shock.	....	....	Colla, Bibl. Ital.
—— —— 8.	Rungpoor in Bengal ...	....	....	....	Asiatic Journal, N. S. vol. xiii. pt. 2. p. 91.
—— —— 21.	Ditto	Two shocks	....	Fissures opened in the ground, from which smoke and flames were thrown out, and then the fissures closed.	Ditto.
—— Aug. 2. 8h 40m A.M.	Borgotaro in Tuscany...	A slight shock.........	....	....	Colla.
—— —— Night between 16 and 17. Midnight.	In Norway. Felt at Christiania, Ilvidesöe, in Tellemarken, at Dramnen, Söndmör; Drontheim, Loessöe, in the Gullbrandsdal and Oesterdal, and at Bergen.	Slight at Christiania, but more severe in the rest of Norway. At Bergen the shock appeared to pass from N.W. to S.E.	A ship off Cape Stat felt a shock as if they had touched upon a shoal.	Beds, doors, and windows were set in motion by vibrations and sudden shocks. At Elverum in the Oesterdal the peasants saw a meteor of extreme brilliancy, which deprived them of sight for some moments. At Bergen also a fire-ball was observed, passing from E. to W., and a boatman of the Sambfiord saw another, from which sparks seemed to be thrown off.	Morgenblad. 1834, Nrs. 250. 253. 256; Keilhau.
—— —— 23. 7 and 9 A.M.	Ilvidesöe in Norway ...	Two shocks, one at each of the hours mentioned.	....	Furniture and even houses were violently shaken.	Ditto, Nr. 250; Keilhau.
—— —— —	Vesuvius	Three severe shocks..	....	Caused fissures to open on one of the flanks of the volcano.	Moniteur, 16, 19 et 20 Sept.
—— —— 24.	Ditto	Another shock.........	....	Produced great fissures, from which lava and immense quantities of smoke came forth. The volcano was in a state of active eruption during the following days.	Ditto.
—— —— 25.	In Perthshire, Scotland	A shock	....	....	Communication of M. Plieninger of Stuttgard to M. Perrey.
—— —— 27. 10h 15m or 25m P.M.	Along the coast of Hampshire, at Portsmouth, Gosport, Southampton, Chichester, &c.	At Portsmouth and Gosport, violent shocks, lasting 3 or 4 seconds.	The 'Griper' sloop of war, lying in Chichester harbour, was thrown consi-	At Portsmouth and Gosport, the clouds had been dense in the afternoon, and the atmosphere suffocating, and about 7 to 8 P.M. some peals of thunder were heard. The tempera-	Moniteur, 4 Sept.; D. Milne's Catalogue, *loc. cit.*

1.	2.	3.	4.	5.	6.
			derably over to the south. The noise was very great, and the crew were much alarmed, thinking that a lighter had run against her.	ture had not been known so high since 1822. At Chichester a low rumbling noise was heard before the shock. The appearance of the sunset was extraordinary, and a West Indian gentleman predicted an earthquake. A whirlwind occurred to the west three hours previously. A man on the shore, south of Chichester, heard a loud report like that of a great gun, and immediately afterwards felt the ground shaking under his feet.	
1834. Sept. 3. At Christiania, 8 P.M. At Moss about the same time. At Drontheim, Skien, and Stavanger, between 7^h 30^m and 8 P.M. At Ullensvang, 7^h 45^m.	In Norway	At Christiania the motion was undulatory, from E. to W., and lasted half a minute. At Eidsvold the earthquake was very severe. It consisted of two shocks, with an interval of eight seconds. The second was the more severe. At Porsgrund three shocks were felt in the space of a minute. The motion was also perceived at Laurwig. At Ilvidesöe there were two very severe shocks. At Ullensvang the shocks lasted three or four seconds, and appeared to be more violent than that of the 17th of August. At Bergen the shocks were ac-	The shocks were perceived at sea, in the fiord of Christiania.	At Christiania doors opened, and pictures hung to the walls were set in motion. The shock was particularly felt in the north and east parts of the town. In the observatory of Christiania, built upon porphyritic rock, it was not perceived, while in localities closely adjoining it, which rested on clayey alluvium, it was felt. At Moss articles of furniture were roughly shaken, and at Eidsvold bells rang. At Porsgrund accompanied by a noise in the air. At Ilvidesöe, Nissedal, Hitterdal, and Böe the inhabitants quitted their houses in alarm. At Loessöe the noise was like that of a carriage passing quickly over pavement. At Ullensvang the houses were violently shaken, but persons in the fields perceived nothing unusual. At Bergen glasses were heard to ring and to rattle together in their presses. At Snaasen no shock was felt, but it was observed that the sky on the western horizon seemed all on fire and constantly lit up by lightning, although the heavens in other directions were clear.	Morgenblad, Nrs. 248. 249. 253. 256. 257. 260. 284. 312; Rigstidenden, Nr. 90; Keilhau.

		according to others, from S.E. to N.W.			
1834. Sept. Night between 4 and 5.	At Hardanger in Norway.	A slight earthquake			Keilhau.
——— 7.	Jamaica	A very violent earthquake.			Trans. Geol. Soc. (London) 2nd series, vol. v. p. 610.
——— 13.	Niort in the departm. Deux-Sèvres, and the neighbourhood.	A slight vibration			Comptes Rendus de l'Acad. t. i. p. 129.
——— 17.	In the islands to the south of Drontheim, Norway.	An earthquake shock			Laing's Travels and Residence in Norway (Lond. Longman, 1851), pt. 1. p. 80.
——— 21. 11^h 20^m A.M.	Chichester	Another earthquake		The day was cold and cloudy, after several days and nights of extraordinary and unseasonably hot weather.	D. Milne's Catalogue of British Earthquakes, *loc. cit.*
——— 25.	Constantinople	Two shocks			Moniteur, 15 Oct.; Journ. des Débats, 24 Oct.
— Oct. 4. 8 P.M.	Bologna. And at the same instant at Parma, Padua, and Venice.	A violent shock, succeeded by "soubresauts," and then by an undulatory movement which seemed to pass from E.N.E. to W.S.W., lasting about eight seconds. At Parma, Padua, and Venice a slight shock, lasting two seconds.		Preceded by a very loud hissing noise. The sky was clear, and a very strong cold east wind blew.	Garnier, Météorologie, p. 174; L'Institut, 5 Nov.; Colla.
——— 5. In the morning.	Chichester	A severe shock. The earth quivered for at least 2 minutes.			Annual Register, 1834, p. 152; Journ. des Débats, 30 Oct.
——— 6. 3 and 7 A.M.	Carthagena in Spain	Three shocks, two of which occurred at 3. and one at 7 A.M. Followed by others the next day.		Followed the same day by a tremendous storm of thunder, lightning, and rain.	Communication of M. Colla to M. Perrey.

1.	2.	3.	4.	5.	6.
1834. Oct. 10.	Batavia	Very violent		About thirty miles in the interior, a mountain in part sank into the earth, causing the total destruction of a village at its foot.	Asiatic Journal, N. S. vol. xvi. pt. 2. p. 211.
—— —— 13. About 2 or 3 A.M.	Snaasen in Norway	Lasted eight seconds, constantly diminishing in intensity.		Accompanied by a ringing sound	Morgenblad, 1834, Nr. 313; Keilhau.
—— —— 13 to 18.	In the canton of Glarens (Glaris?) in Switzerland.	Some slight shocks		Mérian gives only the date October 13, $4^h\ 30^m$ A.M. for Glaris.	Colla, Bibl. Ital. t. lxxviii.
—— —— 14. At night.	Kaschau in Hungary	Ditto			Ditto.
—— —— 15, 16, and 17.	A great part of the N.N.E. of Hungary.	Violent shocks		A shock on the 15th at $7^h\ 44^m$ (A.M. or P.M.?) was so severe at Piscatt that many of the houses were rendered uninhabitable. At Mazo-Peter and other places buildings were also ruined. It had rained but thrice in this country since the month of May. The earthquake of the 15th was preceded by dreadful weather (of what kind?).	Ditto.
—— —— 18.	Borgotaro in Tuscany	A slight shock			Colla.
—— Nov. 15 and 16.	Ditto	Slight shocks			Ditto.
—— —— 26.	Island of Martinique	An earthquake			Journ. des Débats, Fév. 1835.
—— Dec. 8. Before sunrise.	Rome	Some slight shocks, more severe in the mountains of Albano.		Chimnies thrown down	Moniteur, 25 Déc. et 2 Janv. suiv.
—— —— 10.	Agram in Croatia	A slight shock, rather stronger at Kouvre. Direction = N.E. to S.W.			Colla, Bibl. Ital. t. lxxviii.
—— —— 22. $7^h\ 55^m$ P.M.	Kiachta in Siberia	A rather violent shock. Lasted five seconds; direction = N.W. to S.E.		Preceded by a dull noise and accompanied by distant thunder. The houses were violently shaken, but not injured.	Communication of M. Colla to M. Perrey.
—— —— 25. Noon.	Montecchio in the Este territory, Montechiarugoto in the Parmesan territory, and the upper hills.	A slight shock			Colla.

6^h 30^m A.M.	in Mexico. Also felt at Mexico.	A violent vibratory ("de trepidation") shock. At Mexico the motion was undulatory, as on the 11th March 1834.	The sea exhibited no disturbance.	The whole town was destroyed	Dupetit-Thouars, Voyage de la Vénus, t. ii. p. 214.
—— —— 12. 7 A.M.	Borgotaro in Tuscany...	A very perceptible undulatory shock.	......	......	Colla.
—— —— — 8 A.M.	Chichester	A slight shock......	......	......	D. Milne's Catalogue, *loc. cit.*
—— —— 20.	Volcano of Cosiguina in Mexico, and the surrounding district within a radius of more than twenty leagues.	The first shock, followed by others on the 21st and following days.	......	Accompanying a violent eruption of the volcano. The attendant subterranean noise was heard at places far removed from the scene of the eruption, and the shower of ashes also extended to enormous distances. The eruption began on the 19th, and was most violent on the 23rd.	Comptes Rendus de l'Acad. t. iv. p. 801, t. v. p. 75.
—— —— 21. 2^h 5^m A.M.	Collecchio and Sala, in the Parmesan territory.	A slight shock......	......	......	Colla.
—— —— 26. 10^h 54^m A.M.	Borgo-San-Domino in the Duchy of Parma.	A very slight shock...	......	......	Ditto.
—— Feb. 5. 8 P.M.	Borgo-S.-Lorenzo in the Mugello, Italy. Also felt at Vicchio.	A rather severe shock, at first vertical, then undulatory, lasting but a few seconds. At 9^h, another rather severe shock occurred, and on the following days, slight tremblings.	......	Preceded by a noise which came from the east. At Borgo-S.-Lorenzo some walls were cracked, but at Vicchio the damage done was more considerable. Perhaps only the same event with that next recorded.	Notizia Manoscritta del Sig. Andreucci di Borgo-S.-Lorenzo, communicated by Sig. Pilla to M. Perrey.
—— —— 6. 7^h 50^m P.M.	Florence. The centre of disturbance appears to have been situated in the northern part of the Mugello, where, however, there was not much damage done.	A severe shock. Several other slighter ones during the evening.	......	......	Journ. des Débats, 20 Fév.; Colla.
—— —— 7.	Rome and the environs..	A slight shock......	......	......	Colla.
—— —— 9. 10^h 45^m (A.M. or P.M.?).	At sea, in 0° 57′ S. lat., and 25° 39′ W. long. (from Paris).	......	On board the barque 'La Couronne' of Liverpool a shock	......	Daussy in the Comptes Rendus de l'Acad. t. vi. p. 514.

1.	2.	3.	4.	5.	6.
			was felt as if the vessel had struck on and grated along a coral reef. On sounding, no bottom was found with 135 fathoms. The ship was going at the rate of six knots with a fine breeze from the E.S.E.		
1835. Feb. 12.	At sea, felt very strongly off the coast of Guiana.				Trans. Geol. Soc. (London), 2nd series, vol. v. p. 610.
——— 14.	Santiago and other parts of Chili.	A slight oscillation, lasting about 20 secs.			Ditto; Phil. Trans. 1836, p. 21.
——— 20. 11h 30m A.M.	Santiago, Concepçion, and the rest of Chili. Also felt on Juan Fernandez. Extended N. to S., from Copiapo to Chiloe, and from E. to W., from Mendoza to Juan Fernandez.	Three oscillations, of which the first was very gentle, and the second and third very violent. Direction, apparently, S.W. to N.E. The earth was not quiet for three days after, and more than 300 shocks were counted between the 20th February and 4th March.	The sea retired from the coast, flowed in again, and again retired, when an enormous wave rolled in to the height of 28 feet above high-water mark, this being followed by another and still larger wave, and that by two small ones. Two eruptions of dense smoke were seen to issue from the sea; and in the place where the second of these occurred a whirlpool was formed in the shape of an inverted cone, as if the sea were pour-	In some places preceded by a rumbling noise; in others none such was heard. Great fissures opened in the earth, from which gases and muddy and salt water were in many places thrown out. The earth is said to have opened and closed rapidly in many places. The direction of the cracks was not uniform, but generally from S.E. to N.W. The loose earth of the valley of the Biobio was everywhere parted from the solid rocks, the opening between them varying from an inch to a foot in width. The coast was permanently elevated to a considerable extent, varying from one to ten feet at different places; on the whole Captain Fitzroy concludes that the land was raised four or five feet in February, and that it returned in April to within two or three feet of its former level. Concepçion, Talcahuano, Chillan, and other towns were thrown down. The earthquake was preceded by fine weather, and followed by storms of wind and rain.	Ditto; Darwin's Journal of Travels in South America, in Voyage of H.M.S. Beagle, p. 372.

			ing into some cavity in the earth. The earthquake was felt on board vessels 100 miles from the coast.		
1835. Feb. 27. 10 A.M.	Delle, Dannemarie, Mulhouse, and other places in the Sundgau, department Haut-Rhin. Not felt at Bâle.	A tremor	....	....	Mérian.
—— Mar. 6. At night.	Cagliari in Sardinia......	Some slight undulatory shocks from W. to E.	....	Accompanied by a violent N.W. wind	Colla.
—— —— 7. 6 A.M.	Beaumont in the department Vaucluse, and Manosque in the Basses-Alpes.	Two shocks, with an interval of six minutes.	....	....	Journ. des Débats, 24 Mars.
—— —— 8. About 9^h 15^m A.M.	Borgotaro in Tuscany...	A strong undulatory shock, lasting 8 secs. Half an hour after, two other shocks, one of which was very slight.	....	Preceded by a sudden loud noise	Colla.
—— —— 12.	Different places in Hungary.	Violent shocks	....	....	Ditto.
—— —— 16. 2^h 40^m A.M.	Borgotaro in Tuscany...	Another slight shock.	....	....	Ditto.
—— —— 21. 2^h 7^m A.M.	Palermo	Severe shocks, with "soubresauts."	....	....	Ditto.
—— —— —— 4^h 23^m A.M.	Ditto	Three other shocks, lasting 5 or 6 secs. The motion was undulatory, from N.E. to S.W.	....	Flashes of lightning darted from a particular group of clouds.	Ditto.
—— April 1. 7 P.M.	Vesuvius, and as far as Naples.	Four shocks........	....	Accompanied by explosions, and a violent eruption of Vesuvius after a long period of repose.	Journ. des Débats, 21 Avril; Archives des Découv. 1835, p. 29 et suiv.; L'Institut, Nrs. 102, 113 et 116.
—— —— 3.	In the county of Szathmar in Upper Hungary.	Violent shocks........	....	....	Colla, Bibl. Ital. t. lxxviii.

1.	2.	3.	4.	5.	6.
1835. Apr. 15. $11^h 45^m$ A.M.	Borgotaro in Tuscany...	Two slight shocks ...	....	....	Colla.
—— —— 18. $6^h 25^m$ P.M.	In the valley of Interlacken, Switzerland.	A very severe shock, lasting nearly a min. Followed, 5 minutes after, by a second, and at $9^h 45^m$ by a third and slighter one.	....	The new building of the château was shaken by three successive shocks, besides formidable vibratory motion. The earth was distinctly shaken as by a blow, and the bell sounded.	Ditto; Mérian.
—— —— 20. 4 A.M.	Borgotaro in Tuscany...	Another very severe shock, undulatory, lasting 5 secs. At 6^h, two other violent shocks, and at 2 P.M. two others, prolonged, and very severe.	....	The shocks at 2 P.M. were accompanied by detonations.	Colla.
—— —— 21. $8^h 30^m$ P.M.	Kischinew in Bessarabia, and at the same instant at Ismäil.	At Kischinew a severe shock from N. to S., lasting 3 or 4 secs.	....	Followed by lightning and a very impetuous wind.	Ditto, Bibl. Ital. t. lxxviii.
—— —— 25. $3^h 45^m$ A.M.	Borgotaro in Tuscany. Felt with the same violence at Pontremoli, Compiano, and Bedonia, and slightly at Bardi.	Another very severe undulatory shock.	....	Accompanied by very intense noise. The inhabitants fled from their houses.	Colla.
—— May 10. About $10^h 30^m$ P.M.	Again at Borgotaro......	Another slight shock.	....	....	Ditto.
—— —— 19. $1^h 10^m$ A.M. at Trieste. Between 1 and 2 at Laybach.	Trieste, and at Laybach in Carinthia.	At Trieste an undulatory shock from S. to N., lasting 4 secs. At Laybach a severe shock.	....	....	Ditto, Bibl. Ital. t. lxxviii; Garnier, Météorologie, p. 175.
—— —— 23.	Boves near Cuneo or Coni in Piedmont.	Two shocks	....	The first shock was of sufficient strength to throw down a great number of chimnies.	Garnier, Météorologie, p. 175.
—— June 12.	Rougemont, Château d'Oex, in the eastern	An earthquake	....	....	Mérian.

	part of the Canton du Vaud. Less severely felt at Villeneuve and Montreux.				
1835. June 16. 0h 29m A.M.	Palma in the island of Majorca.	A very perceptible movement of the ground, in the direction S.W. to N.E.		Preceded by a loud explosion, which lasted two seconds.	Annual Register, 1835, p. 94; Journ. des Débats, 9 Juillet; Moniteur, 10 Juillet.
—— —— 17. 0h 29m A.M. (Same hour as on the 16th.)	Ditto	Another shock, not quite so strongly felt as the last.		Ditto, not quite so loud as the last	Ditto.
—— —— 20. 8h 16m P.M.	Ditto	Ditto, intermediate in intensity between the first and second.		Ditto, intermediate between first and second. The atmosphere was very clear and serene.	Ditto.
—— —— ...	Vesuvius	Some shocks		During the eruption of the volcano	Journ. des Débats, 22 Juin.
—— July 12. 10 A.M.	In the neighbourhood of Zante, in the island of same name.	A severe shock	An hour before, the sea to the south of Cape Vasilico appeared tinged of a reddish colour, like that of safflower, and diffused a strong acid odour (!).		Colla.
—— —— 31. A little before 10 P.M.	Eglisau in the canton of Zürich.	A tremor			Mérian.
—— Aug. 1. 8h 45m P.M.	Borgotaro in Tuscany...	Another shock?		Subterranean noise, lasting several seconds. No shock is mentioned.	Colla.
—— —— 20. Midnight (of the 19th) and 3h 30m A.M.	Liverpool, Lancaster, Clitheroe, Blackpool, and other parts of Lancashire.	The second and more violent shock was vibratory, and lasted about 30 secs.		Accompanied by a noise like that produced by the dragging of heavy artillery over pavement. The motion felt as if the ground were rising and falling.	Annual Register, 1835, p. 128; D. Milne's Catalogue, *loc. cit.*
—— —— 23. 5 P.M.	Kaisarieh in Cappadocia, and the surrounding country. (The Moniteur of Sept. 21 mentions an earthquake at Trebizond in the beginning of August, and says that 300	A terrible earthquake. The shocks continued six hours, during which time it seemed to an observer as if he were tossed upon the surface of a tem-		Preceded at Kaisarieh by the appearance of a thick smoke on Mount Ardscheh, whence there issued flames, accompanied by dreadful noise, like the eruption of a volcano. During the whole period of the earthquake the shocks were accompanied by noise like thunder. More than 200 houses fell at Kaisarieh, and 150 persons perished. All the villages to the	Journ. des Débats, 7 Nov.; Comptes Rendus de l'Acad. t. i. p. 252; Garnier, p. 175; Huot, Cours de Géol.; Gentleman's Magazine, N. S. vol. v. pt. i. p. 195.

1.	2.	3.	4.	5.	6.
	houses were destroyed by it at Kaisar. This no doubt refers to the event here recorded.)	pestuous sea. The shocks recurred, though with much less violence, up to the 1st Sept.		south of this place, for a circuit of more than 30 miles, suffered dreadfully, almost all the habitations being utterly destroyed, and many of the people losing their lives. Kumetri is said to have been swallowed up, and a lake formed in its place. The Gentleman's Magazine gives the date August 25.	
1835. Aug. 26. (?)	Singapore	Lasted a few seconds.			Asiatic Journal, N. S. vol. xix. pt. 2. p. 128.
—— —— 30. 7h 8m A.M.	Constantinople	A slight shock			Colla.
—— Sept. 14.	Niort in the departm. Deux-Sèvres, and St. Jean-d'Angely in the departm. Charente-Inférieure.	A shock			Moniteur, 7 Oct.
—— ——	Die, Saillans, and Valréas, in the departm. Drôme, and west of La Lance.	A subterranean commotion.		Accompanied by noise. It is observed that the lines joining these places and those last mentioned (Niort and St. Jean-d'Angely), are very nearly parallel, but it seems improbable that the shock felt in both districts was the same, particularly as in each case it was only felt over a space of some myriamètres.	Ditto.
—— —— Day not given. Between 6 and 7 A.M.	In the arrondissement of Yvetot, and at Bourg-Dun in the arrondissement of Dieppe, department Seine Inférieure. Felt over a space of but two myriamètres.	A slight shock, lasting not more than 5 or 6 secs.	Also felt by some sailors who were out fishing.	A dull noise was heard, and some articles of furniture were shaken about.	Garnier, Météorologie, p. 176.
—— Oct. 12. In the middle of the night.	In Calabria Citra, and on the confines of the adjoining provinces. The centre of disturbance seems to have been at Castiglione in the commune of Cosenza.	Violent shocks. The first lasted 4 secs., and was followed by ten others the same night, and several more during the following days.		Castiglione was utterly destroyed and razed to the ground. Out of its 1000 inhabitants, 100 perished beneath the ruins, and many others were grievously injured. At Cosenza the buildings were seriously damaged, but no lives were lost. In other neighbouring districts there were 30 persons killed and as many wounded.	Journ. des Débats, 9 Déc.; Moniteur, 10 Déc.; Colla.

1835. Oct. 27. About 4 A.M.	St. Bertrand de Comminges in the department Haute-Garonne. Also felt at Louzer, Valcabrère, Izaout, Anla, and the whole neighbourhood.	A very severe earthquake. The motion was quick, undulatory, and lasted nearly a minute. The direction of this movement was E.S.E. to W.N.W., which is said to be precisely the direction of the beds of compact limestone of the lower chalk on which St. Bertrand is built, and also the direction of the whole chain of the Pyrenees. An hour after the first shock a second was felt at St. Bertrand.	....	At St. Bertrand de Comminges the shock was sufficient to throw loose articles and furniture in the houses several inches off the floor. It was accompanied by a subterranean noise like the rolling of a heavy cart.	Journ. des Débats, 5 Nov.; Moniteur, 6 Nov.; Comptes Rendus de l'Acad. t. i. p. 322 et 469; Garnier.
—— —— 28. About 3h 45m A.M.	Lux, near Baréges in the same district.	A severe shock, the most violent remembered at this place. Direction = W. to E. Lasted 4 or 5 seconds. Two other shocks, but of much less severity, were felt, with an interval of a quarter of an hour.	....	All the furniture in the houses was displaced ...	Ditto.
—— —— —— About 4h 30m A.M.	Tarbes in the departm. Hautes-Pyrénées, and for several leagues round.	Shocks, which are said to have lasted several minutes at Bagnères. They were considerably increased in violence and duration in the places nearest to the Pyrenees.	....	At Bagnères the inhabitants fled in alarm from their houses. Some walls and ceilings were cracked. The shocks were followed by a loud noise like the rolling of thunder amongst the gorges of the Pyrenees. Direction = W. to E.	Ditto.

1.	2.	3.	4.	5.	6.
1835. Oct. 29. About 4 A.M. (At Bâle, at $3^h 47^m$.)	St. Gall, Appenzell, and the neighbouring district, Switzerland. Also felt at Bâle.	A violent shock	....	Several bells were made to sound. A dull sound like the report of a cannon in the distance was heard. Luminous meteors were observed.	Colla; Mérian.
—— Nov. 1. 3 A.M.	In the Moluccas islands.	A violent and destructive earthquake. In Amboyna the single shock on this day lasted 35 secs. It was the most violent, but other shocks were felt on the 4th.	....	Preceded for three weeks by a heavy sulphurous fog. A volcanic eruption at the same time at Gunong Api in the island of Banda. Buildings were ruined and many persons lost their lives.	Asiatic Journal, N. S. vol. xx. pt. 2. p. 173.
—— —— 11.	Concepçion in Chili ...	A severe earthquake..	....	The volcanos of Osorno and Corcovado, at the distance of 400 miles, were in violent action.	Trans. Geol. Soc. (London), 2nd series, vol. v. p. 610.
—— —— 12. Middle of the night.	Castiglione and other parts of Calabria Citra.	Followed at intervals by ten other shocks.	....	This doubtless refers to the event recorded under Oct. 12; but which is the correct date?	Annual Register, 1835, p. 154.
—— —— 24. 4 P.M.	At the Dardanelles......	Severe shocks	....	....	Colla.
—— —— End of the month. During the night.	Pau in the department Basses-Pyrénées.	Some persons *supposed* they had remarked earthquake shocks.	....	Others said they had heard subterranean noises like loud explosions. After rather severe cold the weather suddenly changed, and a hot suffocating south wind arose.	Moniteur, 3 Déc.
—— Dec. 17. In the morning.	Athens. Felt also simultaneously at Thebes.	At Athens two shocks, one of which was very violent.	....	....	Colla.
1836. Jan. 3.	Mindanao, one of the Philippine isles.	Very violent............	....	Several volcanos in Mindanao active at the time.	Asiatic Journal, N. S. vol. xx. pt. 2. p. 236.
—— —— 11. $4^h 3^m$ A.M.	Rome and the environs.	Two undulatory shocks.	....	An account written some time after says that since this earthquake the atmosphere had been extremely warm, the evenings resembling those of spring. A more violent shock was expected.	Garnier, p. 178; Colla.
—— —— 24.	Chandernagore and Sook Saugor, Hindostan.	....	....	....	Asiatic Journal, N. S. vol. xx. pt. 2. p. 187.
—— —— 28. 9 P.M.	At sea, in 0° 40′ S. lat. and 22° 30′ W. long. (from Paris).	....	On board the ship 'Le Philanthrope' of Bordeaux, a shock was felt which made	....	Daussy in the Comptes Rendus de l'Acad. t. vi. p. 514.

			for three minutes, as if she had struck upon a bank. Also felt on board an American ship, ten miles to the west of the 'Philanthrope,' at the same time.		
1836. Feb. 9. 5 P.M.	Different places in the county of Simegh in Hungary.	A very severe shock...	The next day the waters of a lake were still very much agitated, and rose to an extraordinary height.	Preceded by terrible noise, and extraordinary disturbances in the atmosphere. At Zallës-Gyorok the ruins were numerous. In some places flames issued from the ground.	Colla, Bibl. Ital. t. lxxviii.
—— —— 23. $0^{h}\ 33^{m}$ P.M.	Parma and the neighbourhood.	A very slight shock from E. to W., lasting 2 secs.	....	....	Colla.
—— —— 24.	In the neighbourhood of Sala in the duchy of Parma.	Another very slight shock.	....	....	Ditto.
—— —— 26.	Ditto	Ditto	....	....	Ditto.
—— March. Beginning of the month.	Kaisarich in Asia Minor (Cappadocia).	Severe undulatory shocks.	....	....	Ditto.
—— —— 26. $3^{h}\ 50^{m}$ A.M.	Fribourg in Switzerland.	Three very severe shocks.	....	....	Ditto; Mérian.
—— April 4. In the morning.	In Shropshire	A shock	....	....	Communication of M. Plieninger of Stuttgard to M. Perrey.
—— —— 24. At night.	District of Rossano in Calabria Citra, especially the communes of Rossano and Croscia. Also felt at Cinosa in the province of Otranto, Craco in the Basilicata, and at Naples.	A terribly destructive earthquake. At Naples two shocks were felt during the night.	The sea retired forty paces at one part of the shore, and advanced to an equal extent at another. Volcanic substances and fish of species unknown to the fishermen were thrown upon the beach.	In Rossano, an instant after the shock, all the houses were seen either thrown down or crumbling into ruins; and in Croscia not a single house was left standing. Long and deep fissures opened in the earth. An igneous meteor was seen, having the appearance of great beams on fire. At Cinosa and Craco some buildings were thrown down. The next day Vesuvius sent forth thick smoke.	Garnier, Météorologie, p. 178; Colla.

1.	2.	3.	4.	5.	6.
1836. May 9. 2^h 44^m P.M.	Spalatro in Dalmatia, and the neighbourhood.	A severe shock. The motion was at first undulatory, from S.E. to N.W., but then became vertical.	....	Preceded by subterranean bellowing noise. At the time of the most severe shock a violent S.E. wind blew.	Colla.
—— —— 13. About 5 A.M. At Parthenay, 5^h 3^m A.M.	Angers, Nantes, and Parthenay, in the west of France.	At Angers several shocks. At Nantes a slight vibration. At Parthenay two shocks, more violent than at the other places, from N.W. to S.E., succeeding each other with but little interval. Followed at 10^h 30^m P.M. by another shock in the same direction, but slighter.	....	Preceded at Angers by a dull sound. In many houses the windows and articles of furniture were violently agitated. At Parthenay the shocks were accompanied by subterranean noise like distant thunder. The second caused a general and violent tremor. Persons who were up felt themselves raised from the ground; others who were in bed and asleep were wakened by a commotion like that produced by an electrical machine (an electric shock?), and felt themselves ill for a considerable time.	Journ. des Débats, 17 et 19 Mai; Bull. de la Soc. Géol. t. vii. p. 260; Bibl. Ital.
—— —— 14.	La Rochelle..............	A slight oscillatory motion.	....	....	Ditto.
—— June 11 to 18.	In the province of Trevisa. The shock of the morning of the 12th was felt at many places in Upper Italy.	Very severe shocks. The first, on the 11th at 11 P.M., was followed by a more violent one at 3^h 35^m A.M. the next morning, and by sixteen others of less severity in the course of the week. The shock of the morning of the 12th was particularly distinct at Venice, where it seemed to pass from E. to W.	....	In the district of Ascoli houses were thrown down and others much injured. There had been a shock at Venice about the beginning of the month.	Moniteur, 24 Juin et 26 Sept.; Garnier, p. 180; Colla.

1836. June 12 and 13.	Parma	Slight shocks			Ditto.
—— —— 15. 1 P.M.	Frascati in the Romagna.	Two slight shocks			Ditto.
—— —— 21. 4 A.M.	Venice	An undulatory shock from N.E. to S.W., lasting 4 or 5 secs.		Accompanied by subterranean noise	Ditto.
—— —— 22 and 23.	Different places in Central America.			Accompanying the eruption of a volcano to the east of Omoa. Perhaps this event occurred, not in June, but on the 22nd and 23rd of May.	Journ. des Débats, 23 Juillet; Communication of M. Colla to M. Perrey.
—— —— 29. $2^h 28^m$ A.M.	Laybach in Carinthia	An undulatory shock from E. to W.			Colla, Bibl. Ital. t. lxxviii.
—— July 7. $6^h 15^m$ P.M.	Soleure and the neighbourhood.	A severe shock from S. to N.			Ditto; Mérian; Studer.
—— —— 15. $0^h 35^m$ P.M.	Parma	A very slight shock from E. to W.			Journ. des Débats, 4 et 6 Août; Moniteur, 6 Août; Garnier, p. 180; Colla.
—— —— —— 1 P.M.	Venice	Two undulatory shocks from N. to S., the first lasting 3 seconds and the second 4.			Ditto.
—— —— 20. About noon.	Bassano and the neighbouring places, government of Venice, in Upper Italy, the Tyrol, as at Innsbruck, and at Munich.	At Bassano and the neighbouring places there were three shocks, of which the most severe occurred at noon.		Along the mountain from Borso to Passagno some houses were thrown down, and some persons lost their lives, and at Passagno many houses were injured. At Brixen it seemed as if some one were marching with heavy tread up and down in the room overhead, and a noise was heard like distant thunder. The next day an icy storm, following upon suffocating heat.	Ditto.
—— Aug. 8. Midnight (of the 7th?), and 3 A.M.	Smyrna	Five shocks, the first of which was from N. to S., and very severe.		At 10 P.M. a luminous meteor had been seen, which sent forth numerous sparks.	Colla.
—— —— 11. $5^h 45^m$ A.M.	Messina	A very slight shock			Ditto.
—— Sept. 16. 1 P.M.	Nismes in the departm. du Gard, and more distinctly at Vauvert and some neighbour-	A general tremulous motion, lasting 2 or 3 secs.		Accompanied by a loud explosion. Walls and moveable objects distinctly oscillated.	Moniteur, 24 et 25 Sept.; Bibl. Ital.

1.	2.	3.	4.	5.	6.
	ing villages. Also felt at Beaucaire, but not at all at Montpellier.				
1836. Sept. 26. About 7^h 45^m P.M. at Modena. About 8 P.M. at Venice.	Modena, and Venice and the environs.	At Modena a slight undulatory shock, as also at Venice, where the motion was from E. to W., and lasted some seconds.			Colla.
—— —— 27. Towards evening.	Oran on the north coast of Africa.	Two shocks		Objects placed upon articles of furniture were thrown down.	Moniteur, 18 Oct.
—— Oct. 5. A little before 5 P.M.	Zara in Dalmatia	A slight undulatory shock.			Colla.
—— —— Night between 18 and 19.	Sarnen in the canton of Unterwalden, Switzerland.	Severe shocks		The magnetic needle at Milan was much affected on the 18th.	Ditto, Bibl. Ital. t. lxxviii; Mérian; D. Milne's Catalogue, *loc. cit.*
—— —— 24. 10 A.M.	Blytheswood (in Renfrewshire?).				D. Milne's Catalogue, *loc. cit.*
—— Nov. 5. 7 A.M.	Bâle and in the north-west part of Switzerland, on the one side at Lörrach, and on the other in the Leimenthal, at Arlesheim, Schauenbourg, and very slightly at Bistham, Soleure, Sundbau, and Liestal.	Violent shocks from S. to N.		The earthquake at Altkirk about the end of the year mentioned in the Journal des Débats, 30 Janv. 1837, probably refers to the event of this day.	Colla, Bibl. Ital. t. lxxviii; Mérian, pp. 67 et 84.
—— —— 13. At night.	Various places in Croatia.	Numerous and violent shocks, which continued, though with less intensity, up to the 16th.			Colla, Bibl. Ital. t. lxxviii.
—— —— 18. 6^h 30^m to 10 A.M.	Ditto	More shocks			Ditto.

1836. Nov. 20. 8 A.M.	Naples	A violent shock		The following night a loud noise heard from the interior of Vesuvius. Some peals of thunder also heard.	Journ. des Débats, 8 Déc.; Moniteur, 9 Déc.
—— —— 21.	Grenada in Spain and the surrounding localities.	Severe shocks			Colla, Bibl. Ital. t. lxxxvi.
—— —— 22.	Various places in Croatia.	More shocks			Ditto, t. lxxviii.
—— —— Night between 28 and 29 (O.S. or N.S.?). About midnight.	Slato or Slaskow in the Oural. Also at the village of Turgojack, and in the neighbourhood of the mines of Kischtimski.	A severe shock from N.E. to S.W., lasting 3 secs.		Preceded by a subterranean noise like that of several carriages passing over pavement. This event is probably dated according to old style, and, if so, is doubtless the same with the next recorded.	Communication of M. Colla to M. Perrey.
—— Dec. 11.	Slatoust, Kychtinsk, and Turdojask, in the southern part of the Oural.				v. Humboldt, Asie Centrale, t. ii. p. 119.
—— —— 23. 9^h 30^m A.M.	Eglisau in the canton of Zurich, Switzerland.	A vibration			Mérian.
1837. Jan. 1. 3^h 40^m A.M.	Ancona	A severe undulatory shock from E. to W.			Colla.
—— —— —— A little after sunset.	In Syria, extending over a district of 500 miles in length by ninety in breadth. Less severely felt in the north. The centre of disturbance was supposed to be the subterranean volcano which throws forth the bitumen into the Dead Sea (!).	A most disastrous earthquake. The violent shocks of this day were followed by others up to the middle of the month. At Tripolis but a single violent shock was felt.	During the earthquake the waters of Lake Tiberias were in a state of violent disturbance.	From Beyrout and Damascus to Saphit, the devastation of the country continually increased. In the latter place not one stone was left upon another, and out of the population of 4000, 3500 persons perished beneath the ruins. Tibissorde was ruined, and Jaffa, St. Jean d'Acre, Tiberias, &c. suffered greatly. Whole villages are said to have been swallowed up. Those of Lubic and Rani were completely destroyed, whilst Keffar-Renna (the ancient Cana in Galilee), situated between the two and near Rani, had not a single house thrown down, and the shock was very little felt there. Deep fissures were formed in solid rocks, and at Tabarich new hot springs made their appearance. At Nazareth the earth opened for 112 feet in length by 1¼ foot in breadth, and then closed within ⅜ths of this breadth again.	Journ. des Débats, 24 Fév., 17 Mai, et 1 Juin; Moniteur, 24 Fév. et 22 Mai; Garnier, Proceedings Geol. Soc. (Lond.) vol. ii. p. 658; Annual Register, 1837, p. 15; Asiatic Journal, N. S. vol. xxiv. pt. 2. p. 175.

1.	2.	3.	4.	5.	6.
1837. Jan. Night between 10 and 11. About midnight.	Poitiers in France	Two shocks, one of which was very severe.	....	....	Colla, Ann. Astr. 1839, p. 109.
—— —— 21. About 2, and 4 or 5 A.M.	Geneva....................	Two severe shocks ...	....	....	Ditto; Journ. des Débats, 30 Janv. et 1 Fév.; Moniteur, 2 Fév.; L'Institut, Nr.218.1837; Garnier.
—— —— 24. About 2 A.M. At Altkirk, at $1^h 45^m$ and some mins. after 2^h. At Stuttgardt & Oberndorf, at $1^h 54^m$, & $2^h 11^m$. At Sion & Brieg, at $1^h 58^m$. At Constance, 2 A.M. At Berne, about $1^h 47^m$, and $2^h 7^m$. At Besançon, $2^h 32^m$.	Altkirk, Besançon, Bâle, Berne, Soleure, Constance, Sion, Burdorf, Stuttgardt, Oberndorf, Zurich, Dorneckdorf in the canton of Soleure, Geneva, Brieg, and other places in the duchy of Baden, in Würtemberg, Alsace, Switzerland, Lombardy, and Piedmont.	Severe shocks. At Altkirk there were two, the first lasting eight seconds, the second a shorter time. At Stuttgardt and Oberndorf there were also two shocks; direction = E. to W. At Sion and Brieg there were likewise two; at Burdorf three, in the direction S.S.W. to N.N.E. At Constance a violent shock, followed by another half an hour after. At Zurich the shocks were violent but of short duration. At Berne, three shocks, the two latter of which were less distinct than the first, and occurred at $2^h 7^m$. At Bâle and in the neighbouring communes two or perhaps three move-	....	At Altkirk the first shock was preceded by a noise like the fall of a mass of stones. The air was calm and clear. At Sion and Brieg the attendant noise seemed to pass from S. to N. The hygrometer at Sion, which had been so steadily fixed between 90° and 100° for two months that the instrument was supposed to be out of order, suddenly rose 15°. At Bâle persons who were asleep were wakened, and at Soleure some cages of birds were thrown down. At Besançon the first shock threw loose objects from S. to N., and then back again from N. to S.	Ditto; Bull. de l'Acad. Roy. de Bruxelles, t. iv. p. 74.

		ments were felt. At Dorneckdorf there were two shocks, N. to S. At Brieg the shocks and attendant noise recurred for several days. At Besançon, two shocks with an interval of half a second. The first shock was from S. to N. and then N. to S., the second was from E. to W. In Lombardy and Piedmont the motion was from N. to S.			
1837. Jan. 25. $3^h\ 6^m$ A.M.	Zurich	A slight shock			Mérian.
—— —— 28. $11^h\ 58^m$ P.M.	In the canton of Soleure. Felt more strongly at Seeberg and Steinhof than at Soleure.	Very distinct shocks.			Ditto; Colla, *loc. cit.*
—— —— 29.	Vizille in the departm. Isère.	A strong subterranean movement.		Preceded by a violent explosion, like the simultaneous discharge of several pieces of artillery.	Colla, *loc. cit.*
—— —— Night between 30 and 31.	Slightly felt at Brieg in the Valais, but more violently at some leagues distance, nearer to the sources of the Rhône.	Several shocks			Bull. de l'Acad. Roy. de Bruxelles, t. iv. p. 75.
—— Feb. 14.	Soleure	Slight shocks			Mérian.
—— —— 16.	Ditto	Ditto			Ditto.
—— —— 18. $11^h\ 54^m$ P.M.	Ditto	Ditto			Ditto.
—— —— 19. $7^h\ 30^m$ A.M.	Bâle	A very slight shock		During a storm. Considered very doubtful by Mérian.	Colla, *loc. cit.*
—— —— 20. Midnight.	Soleure	Slight shocks			Mérian.

1.	2.	3.	4.	5.	6.
1837. Feb. 25. About $5^h\ 15^m$ A.M.	Ghent	A rather severe oscillatory shock, from S.E. to N.W., lasting two or three seconds. More severe than that which occurred here eight years before.		During stormy weather. Wind S.S.W. Thermometer $-4^{\circ}{\cdot}5$ R.	Garnier, Météorologie, p. 183.
—— —— 29.	In the southern part of the Oural, at Slatoust, Kychtinsk, and Turdojask near Miask.				v. Humboldt, Asie Centrale, t. ii. p. 119.
—— March 3. Two hours and some minutes after midnight (of the 2nd?).	Zara in Dalmatia	A severe shock, from S.W. to N.E., lasting two seconds.		Preceded by a dull noise	Colla.
—— —— — $8^h\ 45^m$ P.M.	Perugia in Italy	A very distinct shock from N. to S.		The magnetic needle had been disturbed several days before.	Ditto.
—— —— 8. Beginning of the night.	Messina	A severe shock, from E. to W.			Ditto.
—— —— 15. $4^h\ 45^m$ P.M. (The Bull. de l'Acad. Roy. de Bruxelles, *loc. cit.* gives the date March 14, $4^h\ 43^m$ P.M.)	Vienna. Also felt at Brünn, Gratz, Talbu, Lintz, and other places in Austria.	Two shocks, the first at the hour mentioned, the second a few seconds afterwards. From N.W. to S.E. Each shock lasted about two or three seconds. There had been two others at $4^h\ 3^m$ (?).		Bells rang	Bull. de l'Acad. Roy. de Bruxelles, t. iv. p. 127; Moniteur, 27 Mars; Colla, Ann. Astr. 1839, p. 110.
—— —— 18 to April 1, especially on the 20th.	In Hydra and other islands of the Grecian Archipelago; the centre of disturbance apparently at Methone. Also felt at the same time in the interior of Greece.	Disastrous shocks, which in Hydra recurred several times daily.		Some houses in Hydra were thrown down and others injured. In the islands of Spezia, Paros, and Santorin, damage was also done.	Journ. des Débats, 25 Avril; Colla; Garnier; Berghaus, Länder-und Völker-Kunde, B. ii. S. 709.

1837. Mar. 28. 8h 30m P.M.	In the islands of Lagosta and Curzola, Dalmatia.	A very distinct shock from E. to W.		Preceded by a dull noise. In Curzola a luminous meteor had been seen at 6h 15m, which was like a train of fire, and vanished in the east.	Colla.
—— April 11. 5h 30m P.M.	Ugliano and other places in Upper Italy. Extended from Genoa to Florence. The centre of disturbance seems to have been the Pizzo-di-Ucello, one of the highest peaks of the Apuan Alps.	The first shock at the hour mentioned was followed by others until the next morning, in which time thirty-two were counted. According to some accounts the motion was undulatory, according to others vibratory and perceptibly vorticose.		Preceded by a terrible rumbling noise (rombo). Houses were thrown down, and some persons lost their lives. The Pizzo-di-Ucello was seen to shake, while avalanches of snow and huge masses of rock descended from its sides. The mineral waters of Equi were troubled. The earth opened in several places.	Ditto; Journ. des Débats, 27 Avril; Giornale Agrario Toscano, Nr. 43.
—— —— 12.	Hartford in Connecticut	Very slight			Silliman's Journal, vol. xxxii. p. 339.
—— May 27. About 6 P.M.	Coblentz	A slight shock			Garnier, Météorologie, p. 183.
—— —— 28. 6h 35m A.M.	Island of Martinique	A very strong shock		The volcanic phænomena previously observed in Guadaloupe did not extend to Martinique.	Comptes Rendus de l'Acad. t. v. p. 194.
—— —— —— In the evening.	In the environs of Rome, at Velletri, and principally in the district of the extinct volcano of Monte Lopiale.	Several very distinct shocks.			Journ. des Débats, 13 Juin; Garnier, p. 185; Colla.
—— —— 29. Before sunrise.	Albano, Marino, Frascati, &c., in the neighbourhood of Rome.	Three severe shocks			Ditto.
—— —— 31. 5h 15m A.M.	Innsbruck in the Tyrol.	Two severe shocks			Garnier, Météorologie, p. 186.
—— —— ...	Some places in the departm. du Cher.	Severe shocks			Colla, *loc. cit.*
—— June 1.	In the neighbourhood of Monte Laziale (Lopiale?), near Rome.	Several shocks			Journ. des Débats, 13 Juin; Garnier, p. 185; Colla.
—— —— 10. (O. S.) 6h 30 P.M.	Petropawlowski in Kamtschatka.	A slight earthquake		The air calm and sky clear. Thermometer, 10°·3 R. Barometer, 29·95 inches (English or French?).	Dupetit-Thouars, Voyage de Vénus, part. Phys. t. iv. p. 444.

1.	2.	3.	4.	5.	6.
1837. June 21. Some minutes before 11 A.M.	Bleibourg, Guttenstein, and Schwarzenbach, in Illyria. Extended as far Schönstein in Styria.	A rather severe earthquake, lasting some seconds.	....	Preceded by a noise like the rolling of thunder...	Garnier, p. 186; Colla, Ann. Astr. 1839, p. 111.
—— July 26.	Island of Martinique ...	Several shocks.........	Accompanied by a terrible "raz de marée."	During a dreadful hurricane	Journ. des Débats, 15 Sept.
—— Aug. 2.	Island of St. Thomas ...	....	....	Accompanying the tremendous hurricane which devastated the West Indies on this day. The account seems very doubtful.	Moniteur, 17 Sept.
—— —— —— At night.	Sydney and Newcastle in New South Wales.	....	....	Accompanied by a noise like the distant discharge of artillery.	Asiatic Journal, N.S. vol. xxv. pt. 2. p. 29.
—— —— 3. In the morning.	In the island of Zante. Slightly felt at the same time in Cephalonia and various places in the Morea.	Some severe shocks...	....	Some damage done............	Colla.
—— —— 9. $4^h\ 30^m$ P.M. at Acapulco, $4^h\ 15^m$ at Morelia.	Acapulco, Morelia, and Mexico.	At Acapulco the vibratory motion is said to have lasted *a month* almost uninterruptedly, the most severe shocks occurring nearly regularly at intervals of thirty or thirty-two hours. At Mexico the first shock only was felt. It was accompanied by slight undulatory motion. At Morelia there were two shocks with an interval of two seconds, and accompanied by oscillations from S. to N.	....	The buildings of Acapulco were greatly injured. At Morelia a violent tempest from the N.N.E. began at $4^h\ 30^m$, accompanied by thunder and lightning. In the evening a great number of shooting stars were observed.	Dupetit-Thouars, Voyage de la Vénus, t. ii. p. 214; Colla, Giorn. Astron. 1839, p. 111; Bull. de l'Acad. Roy. de Bruxelles, t. viii. pt. 2. p. 438.

		About the end of the month several shocks at Tortola.			
1837. Aug. 21, 9h 15m A.M.	Placenza in Italy	A slight undulatory shock from E.N.E. to W.S.W.			Colla.
—— —— 29.	Island of St. Vincent in the West Indies.	Several shocks			Journ. des Débats, 22 Déc.
—— Sept. 2 to 7.	Aivaly, and on the coast of the Gulf of Adramiti, Anatolia.	Slight but continual shocks.			Moniteur, 30 Sept.
—— —— 4. 5h 30m A.M.	Milan	A shock, from E. to W. lasting two seconds.			Colla.
—— —— —— 10 A.M.	Ario in Mexico. The origin apparently in the volcano of Jorullo.	Gentle oscillation from S. to N.		Some hours after, a violent storm, the summit of Jorullo being enveloped in a grey cloud, which afterwards cleared away and left a serene sky. Many shooting stars observed at night.	Bull. de l'Acad. Roy. de Bruxelles, t. viii. pt. 2. p. 438.
—— —— 6.	Island of Barbadoes	Several shocks, one of which lasted twenty seconds.		Some damage done by the shock of twenty seconds.	Journ. des Débats, 22 Déc.
—— —— Night between 6 and 7. (N. S.)	Petropawlowski in Kamtschatka.	A slight shock	Not felt on board the 'Vénus.'	The horizontal magnetic needle on shore presented no marked disturbance. The shock seems, like many others, to have been felt only on one of the two hills of the town. It is said that earthquakes and volcanic eruptions are common in Kamtschatka, but that storms and the aurora borealis are rare, notwithstanding the high latitude.	Dupetit-Thouars, Voyage de la Vénus, t. ii. p. 25. et part. Phys. t. v. p. 173 et suiv.
—— —— 19. 3h 45m A.M.	Eglisau in the canton of Zurich.	A very severe shock, consisting of a sudden sharp jerk. Half an hour after, another slight shock.		The second shock was accompanied by a dull rumbling noise.	Colla.
—— —— 22. 3 A.M.	Lasaya in Van Diemen's Land. Extended also to Maya on the coast of New Holland. (Where are these places situated?)	Violent and disastrous earthquake, which continued until dawn.	The sea made inroads upon the shore, and a new island was formed (owing to the earthquake or the storm?).	On the evening of the 21st terrible explosions were heard at Lasaya, and long luminous streaks of bright red were seen on the horizon; the whole sky then became of the same colour. During the earthquake the surface of the ground was in motion like that of the waves	M. Perrey's Memoir on Earthquakes in the basin of the Rhine, p. 94.

1.	2.	3.	4.	5.	6.
				of the sea, while every five minutes the explosions became terrible. The atmosphere was heavy, and was lit up by flashes of lightning. Lasaya and Maya were thrown down and filled with corpses. A terrible tempest at the same time.	
1837. Sept. 22. Noon.	Agram in Servia. Felt in the neighbourhood and in the mountains.	A violent shock from N. to S.	....	Accompanied by subterranean noise like thunder. Walls were cracked. Thermometer in the shade +15° Reaum. Barometer, 28′ 4″ 8‴ (Viennese).	Journ. des Débats, 9 Oct.; Moniteur, 10 Oct.; Colla, Ann. 1839; p. 112.
—— —— End of the month.	Penang and Acheen in the East Indies.	The shocks lasted for seven days.	....	Volcanic eruptions took place in the neighbourhood of Acheen.	Asiatic Journal, N. S. vol. xxv. pt. 2. p. 232.
—— Oct. 3.	Vera Cruz	Several shocks........	....	Numerous shooting stars observed about this time at Guadalajara, 237 leagues from the shore of the Atlantic.	Bull. de l'Acad. Roy. de Bruxelles, t. viii. pt. 2. p. 439.
—— —— 4. 5 A.M.	Eglisau in the canton of Zurich.	A severe shock	....	....	Mérian.
—— —— 6. Afternoon.	Agram (in Croatia?) ...	Severe shocks	....	Accompanied by explosions which recurred at intervals of half an hour. Low bellowing noises had been heard for several days. Many houses thrown down.	Journ. des Débats, 8 Nov.; Moniteur, 9 Nov.; Colla, Ann. 1839, p. 112.
—— —— 11. $7^h 30^m$ P.M.	Tilly - la - Campagne, Bourguibus, and Sollins, in the departm. Calvados.	Violent shock	....	Accompanied by loud explosions	Journ. des Débats, 18 Oct.; Colla.
—— —— 18. About 4 P.M.	Acapulco in Mexico. Felt also with considerable force at Mexico.	A violent earthquake, vibratory, lasting more than a minute in all its force. Up to 9 P.M., 130 shocks were counted. The shock of 4 P.M. lasted more than 2½ minutes at Mexico.	....	....	Dupetit-Thouars, Voyage de la Vénus, t. ii. p. 214; Moniteur, 15 Janv. 1838; Comptes Rendus, t. vi. p. 180.
—— —— 19. $0^h 30^m$ A.M.	Ditto	Another shock of extreme violence, followed in an hour by another still more	....	Everyone was roused by the second shock, which produced extensive ruins. Loud subterranean bellowings were heard during the whole night, and continued during the day.	Ditto.

		slighter ones throughout the day.			
1837. Oct. 19. 10 P.M.	Ditto. The shock at midnight was very severe at Mexico, but not of long duration.	Two very severe shocks, followed by a third about midnight. The earth continued to tremble at intervals up to the 21st.	....	Accompanied by ringing noises. The third shock threw the whole town into alarm.	Ditto.
—— 20. 2 P.M.	Liskeard in Cornwall, and the country in the vicinity, both in Devonshire and Cornwall.	....	....	Accompanied by a sound like the rattling of a cart.	Trans. Roy. Geol. Soc. of Cornwall, vol. v. p. 142 (note), quoting the Cornwall Royal Gazette Newspaper of 27th Oct. and 3rd of November 1837.
—— 21. 2 A.M.	Acapulco	Another shock, rather severe; the earth then trembling until the next day at 10 A.M.	....	....	Authorities for Oct. 18.
—— 22. 10 A.M.	Ditto	Another severe shock. After this the earth was less disturbed; the shocks recurred periodically at 10 P.M., midnight, 6 A.M., and 4 P.M., for twenty days without ceasing. All the oscillatory movements were from W. to E. up to the 12th of November, after which time they recurred with more force at the same times as before, but in the opposite direction, or from E. to W. In	No perceptible elevation or depression of the waters of the sea was produced by any of these shocks.	....	Ditto.

1.	2.	3.	4.	5.	6.
		December the movements were again from W. to E., and thence up to January 1838 they daily diminished in intensity and frequency.			
1837. Oct. 27.	Camelford in Cornwall..	Several shocks........	....	Accompanied by dull noise. Is this a different earthquake from that of the 20th?	Colla, Giorn. Astron. 1839, p. 112.
—— —— 30. Some minutes before 11 P.M.	Mulhouse and Breisach in the departm. Haut-Rhin.	A rather severe shock from E. to W.	....	The wind, which was from the south, and already very violent, changed to a tempest immediately after the shock.	Journ. des Débats, 11 Nov.; Colla; Mérian.
—— —— 31. 0h 58m A.M.	At Murcia in Spain ...	A violent shock from N. to S., lasting 8 or 10 seconds.	....	The atmosphere was suffocatingly hot and close. Buildings of the greatest solidity were violently shaken.	Journ. des Débats, 17 Nov.; Moniteur, 18 Nov.
—— —— —— 2 to 9 A.M.	Torrevieja in the same district.	Shocks comparable in violence to those of March 1829. During the period mentioned 400 were felt, without any interval longer than a few minutes between each.	....	....	Ditto.
—— Nov. Night between 2 & 3.	Carlsruhe................	A slight shock........	....	....	Mérian.
—— —— 7.	In Chili	A violent earthquake.	Extraordinary movements of the ocean were observed in the Pacific. A whale-ship within sight of land in 43° 38′ S. was violently shaken and lost her masts.	Valdivia was ruined. The captain of the whaler mentioned in Col. 4, found in a spot near the island of Lemus (Chonos Archipelago), where he had anchored two years before, that the bottom of the sea had been permanently raised more than 8 feet. The whole coast was strewn with uprooted trees.	Comptes Rendus de l'Acad. Oct. 1838, p. 706.
—— —— 12. In the evening.	Lucerne	A severe shock	....	During the night of the 12th and 13th a beautiful aurora borealis was observed at different places in Europe.	Colla, Giorn. Astron. 1839.

1837. Nov. 22. 11h 58m P.M.	Guadalajara in Mexico. Also felt, a quarter of an hour later, at Mexico.	Three shocks, from W. to E., very violent.	....	The origin was supposed to be in Cebo Rujo, a volcano to the west of Guadalajara.	Bull. de l'Acad. Roy. de Bruxelles, t. viii. pt. 2. p. 439.
—— —— 24.	Camelford in Cornwall..	....	....	The account of October 27 probably refers only to this event.	D. Milne's Catalogue, *loc. cit.*
—— —— 30. 8h 30m P.M.	Island of Martinique ...	A severe shock	....	The temperature was high; it had been cool for several days before.	Comptes Rendus de l'Acad. t. vi. p. 302.
—— Dec. 8. 11h 15m P.M.	Stamford in Lincolnshire, and the country for twenty miles round.	Ditto	....	....	Journ. des Débats, 23 Déc.
—— —— 11. 3h 7m A.M.	Chalabre and Ste Colombe in the departm. Aude. A slight shock was also felt at several places in the Arriège and Pyrénées Orientales.	A shock of thirty seconds' duration.	....	Accompanied by a noise like that of carriages rolling over pavement.	Ditto; 18 Déc.; Colla, *loc. cit.*
1838. Jan. 5. 7h 15m and 7h 30m A.M.	Belley in the departm. Ain.	Two pretty distinct shocks, each lasting a second.	....	Accompanied by loud noise	Colla, Ann. Astr. 1840.
—— —— 8 to 14.	Spoleto and the neighbourhood, States of the Church.	Very violent shocks...	....	Some persons asserted that they had seen flames issue from the earth.	Colla.
—— —— 8 to 23.	Acapulco in Mexico ...	During this period (while the Vénus was in the port of Acapulco) thirty-four very slight shocks were felt, and one of somewhat greater severity.	....	During this period the declination needle was carefully observed, but showed no symptom of disturbance in consequence of the earthquake shocks.	Comptes Rendus de l'Acad. t. ix. p. 330.
—— —— 11.	Bucharest	An earthquake	....	....	Ditto, t. vi. p. 900.
—— —— 14. 7 A.M.	Tynehead in Northumberland.	A shock of sufficient force to throw down articles of furniture.	....	The next day a rent was remarked in the fields of more than half a mile in length, which was supposed to have been caused by the earthquake. Milne, in his Catalogue of British Earthquakes, gives the date January 21 for this one.	Journ. des Débats, 25 Janv.; Colla, Ann. Astr. 1840, p. 106.

1.	2.	3.	4.	5.	6.
1838. Jan. 15. About 5^h 30^m P.M.	Gibraltar	Several slight shocks, *in the direction of the walls of the fortress* (!). At 10^h 20^m, a prolonged and very distinct shock, and at 11^h 15^m, a very slight one.			Colla, Giorn. Astron. 1840, p. 106.
—— 21.	Island of Martinique	A slight shock			Communication of M. Colla to M. Perrey.
—— 22.	Tusla in Russia (Bosnia?)	A violent vibratory shock.			Plieninger, Jahrsbericht über die Witterungs-Verhältnisse in Würtemberg.
—— 23. Cronstadt and all Transylvania, at 8^h 31^m P.M. At Odessa, at 9^h 11^m. At Constantinople, at 9^h 35^m. At Clarofka near Cherson, at 10 P.M.	In Transylvania, and parts of Turkey and Russia. The motion does not seem to have extended to the Asiatic side of the Bosphorus.	At Cronstadt and in Transylvania the shocks lasted a minute and thirteen seconds. At Odessa and in Russia they were very violent. At Constantinople there were two shocks, the first vertical, the second horizontal and in the direction of the meridian (which is that of the Bosphorus near Therapia). At Orsova in Hungary the shocks were violent. At Odessa there were two, one vertical and the other horizontal, from N.W. to S.W. (?); lasting sixty seconds. At		In Transylvania the buildings first rocked from side to side, with a motion like that of a balloon, and then the walls cracked and fell. At Constantinople the air was calm during the shocks, but the north wind which had been blowing a little before recommenced soon after. At Scutari the shocks were accompanied by a violent wind. At Hermannstadt, a barometer, not fixed to the wall, but suspended, oscillated for more than half an hour. At the same place and at Cronstadt the sky was clear before the earthquake, became clouded at the time, and cleared again afterwards. At Bucharest the serenity of the atmosphere was not disturbed. At Orsova in Hungary the shocks were accompanied by terrible subterranean bellowings and by flames issuing from the earth. At Clarofka also subterranean noise was heard, like the rolling of a huge waggon over pavement.	Comptes Rendus de l'Acad. t. vi. p. 244; Journ. des Débats, 13, 16, 26 et 27 Fév.; Colla, Ann. Astr. 1840 pp. 106, 107; Les Steppes de la Mer Caspienne. t. i. p. 104.

		four minutes. At Clarofka near Cherson there were two shocks, the first vibratory, the second undulatory and of longer duration.			
1838. Jan. 24.	Pouilly, Toisy, and Mont-St.-Jean, in the departm. Côte-d'Or.	A slight shock........	....	....	Journ. des Débats, 16 Fév.; Colla, Ann. Astr. 1840.
—— —— 24 & 25.	Ismail, Bender, Reni, &c. in Bessarabia.	More shocks	....	....	Plieninger, Jahrsbericht über die Witterungs-Verhältnisse in Würtemberg.
—— —— Night between 24 & 25.	Odessa....................	Slight shocks	....	It was remarked that the barometer, which had been in motion for several days, was much more agitated during these shocks.	Authorities for Jan. 23.
—— —— 25. 4 A.M.	Bucharest and Jassy ...	Another shock, instantaneous and very slight. Shocks were frequent during the last few days in Austrian Gallicia, Transylvania, Hungary, Moldavia, Albania, Wallachia, and Bessarabia.	....	....	Ditto.
—— Feb. 2. At night.	In the valley of Pastusie, Sardinia.	Great subterranean commotion.	....	Accompanied by an explosion which threw everything, minerals and vegetables, to a distance. Part of the ground disappeared in fissures. Bells sounded of themselves. Perhaps not an earthquake proper at all.	Journ. des Débats, 31 Mars.
—— —— 10. $4^h\ 55^m$ A.M.	Cronstadt in Transylvania, and the places near.	Some very slight shocks.	....	During the inundation of the Danube at the end of the winter (some persons said) an earthquake occurred at Pesth. Journ. des Débats, 31 Mars; Moniteur, 2 Avril.	Colla, Ann. Astr. 1840, p. 106, 107.
—— —— 14. $8^h\ 30^m$ A.M.	Foligno and the neighbourhood, States of the Church.	A severe shock, followed by several slighter ones in the course of the day.	....	....	Colla.

1.	2.	3.	4.	5.	6.
1838. Feb. 14. $4^h\ 30^m$ and $6^h\ 30^m$ P.M.	Dijon	Two slight shocks		Accompanied by a violent explosion. M. Perrey, although living at Dijon, says that he himself neither felt the shocks nor heard the noise.	Memoir of M. Perrey on Earthquakes in France, Belgium, and Holland, p. 84.
—— —— 15. $1^h\ 30^m$ A.M.	Foligno	Another shock, more violent than that of the day before.			Colla.
—— —— 17. $8^h\ 45^m$ A.M.	Ditto	Another severe shock.			Ditto.
—— —— 20 to 24.	Naples	Slight shocks		No damage done. Vesuvius was in a state of rest. On the 21st from noon to midnight magnetic perturbations were observed at Milan.	Ditto; Journ. des Débats, 13 Mars; Moniteur, 14 Mars.
—— —— 23. Between 4 & 5 A.M.	In the departm. de la Creuse.	Two shocks			Colla, Ann. Astr. 1840.
—— Night between February 28 and March 1.	Lisbon	A severe shock		Accompanied by thunder and lightning, hail, rain, and wind.	Ditto, p. 107.
—— March 5. $9^h\ 30^m$ A.M.	Eglisau and Rheinau, canton of Zurich.	A severe shock			Mérian.
—— —— 15.	In Hungary, the Bannat, Transylvania, and Wallachia.	Violent shocks			Plieninger, Jahrsbericht über die Witterungs-Verhältnisse in Würtemberg.
—— —— 16. About 1 A.M.	Coblentz	A shock		During a very violent tempest	Colla, Ann. Astr. 1840.
—— —— 17. 1 P.M.	Shrewsbury and the neighbourhood, extending about nine miles from that town, chiefly in a south or south-east direction. Felt in the villages of Meole, Hanwood, Dorrington, Longden, Pontesbury, &c.	A very distinct and alarming vibratory shock.		Accompanied by a rumbling noise, like that of a train of waggons passing along a paved street. Houses, walls, articles of furniture, &c. shook violently. In some of the coal pits the men were so much alarmed that they came up out of the pits. Bells rang, bricks fell from a chimney, &c. Milne in his Catalogue gives a shock on the 27th at 1 P.M., at this same place, but in all probability the account only refers to the event of the 17th.	Annual Register, 1838, p. 39; Shrewsbury Chronicle; Milne's Catalogue of British Earthquakes; Colla, Giorn. Astron. 1840, p. 108.
—— —— —	In Hungary, the Bannat, Transylvania, and Wallachia.	Violent shocks			Plieninger, Jahrsbericht über die Witterungs-Verhältnisse in Würtemberg.

1838. May 5. $10^h 40^m$ P.M.	Genoa. Also *felt* at Piacenza.	A very distinct shock, which recurred at $11^h 35^m$.			Colla.
—— —— 22. 7 A.M.	Meandre in the departm. Isère.	Severe shocks, lasting nearly fifteen minutes, but in three separate sets.		Some walls were cracked	Journ. des Débats, 3 Juin; Colla, Ann. Astr. 1840.
—— —— 26.	In the district between Halle and Eisleben in Prussia.	Some subterranean commotions *supposed* to have been felt.		A dull sound was heard, which according to some persons was subterranean.	Plieninger, Jahrsbericht über die Witterungs-Verhältnisse in Würtemberg.
—— —— ...	Constantine on the north coast of Africa.	An earthquake			Colla, Ann. Astr. 1840, p. 108.
—— June 7. 11 P.M.	Island of Meleda in the Adriatic.	Two slight undulatory shocks, from W. to E., lasting two seconds.		The first shock was preceded by a slight murmuring noise which ended like the report of a cannon.	Colla.
—— —— 23. At Venice, $10^h 18^m$ P.M. At Pesaro soon after $9^h 45^m$.	Venice and Pesaro. Extended, with even more force than at the latter place, along the coast to Fano and Sinigaglia.	At Venice, three slight shocks, from E. to W. The second immediately succeeded the first, but there was a short interval between the second and third. Total duration =8 seconds. At Pesaro the shock was undulatory, from E. to W., and lasted five seconds.		At Venice accompanied by dreadful weather; torrents of hail and rain. At Pesaro, a little before the earthquake, many shooting stars were observed, rather brilliant and of large size. They came from the east, and disappeared about the meridian towards the south. At $9^h 45^m$ a noise like that of four or five "voitures du poste" was heard, followed immediately by another sound, like that which a compressed gas makes in escaping, and, soon after, the earth began to tremble. All the buildings shook to their very foundations. Soon after the earthquake the water rose four French feet in the wells.	Comptes Rendus de l'Acad. t. vii. p. 89. t. viii. p. 344; Moniteur, 1 Août; Colla.
—— July 1. $2^h 15^m$ A.M.	Constantinople	A slight shock			Colla.
—— —— 18. $11^h 45^m$ P.M.	Gibraltar	Shocks			Ditto, Ann. Astr. 1840, p. 109.
—— —— 19. 4 P.M. and $8^h 15^m$ P.M.	Ditto	Ditto. Direction = E. to W.			Ditto.
—— —— 23. $3^h 44^m$ A.M.	Constantinople, and the country for several leagues round.	Two shocks, the latter of which was very violent. Total du-			Moniteur, 21 Août.

1.	2.	3.	4.	5.	6.
		ration, 16 seconds. Horizontal undulations from N.W. to S.W. (?)			
1838. July 30.	Tureff in Scotland. (Where is this place?)	A shock	....	Probably this account and that of the 6th of August only refer to one and the same event.	Communication of M. Plieninger to Mr. Perrey.
—— Aug. Night between 2 & 3.	Naples....................	A slight shock........	....	Etna was in a state of energetic eruption. There was an eruption of Vesuvius also during the first few days of the month, accompanied by some shocks.	Journ. des Débats, 21 Août; Colla.
—— —— 4. 6 P.M., and during the following night.	Huatusco in Mexico ...	Several shocks........	....	During the night numerous shooting stars were observed.	Bull. de l'Acad. Roy. de Bruxelles, t. viii. pt. 2. p. 440.
—— —— 6.	Tureff in Scotland. (Where is this place?)	A very slight shock...	....	....	Colla, Giorn. Astron. 1840, p. 109.
—— —— 7. 5 A.M.	Constantinople	A vibratory shock, lasting 8 seconds, followed at 5h 7m by another shock, of longer duration, after which slight but frequent oscillations were felt for a quarter of an hour.	....	....	Colla.
—— —— 9. In the afternoon.	Fiume and Bukkari on the Adriatic.	A slight shock........	....	....	Ditto; Journ. des Débats, 26 Août.
—— —— 10. 2h 30m A.M.	Ditto	Several shocks.........	....	....	Ditto.
—— —— —— Between 8 & 9 P.M.	Ditto. All these shocks were felt at Trieste.	A shock of greater severity than any of the preceding.	Vessels in harbour were dashed against each other.	Bells sounded of themselves at the Fiume. At Bukkari the great tower of the church fell. A terrible noise preceded the shock.	Ditto.
—— —— 26.	In the county of Zolander (Szalad?) in Hungary. Some of the shocks extended to [illegible]	A very violent earthquake. The shocks succeeded each other for five minutes with such	....	Accompanied by noise like thunder. In some places much damage was done, as at Racz-Kanisa and the castles of Strido and Warasdin, where cracks were formed in many of the houses, and some of them thrown down. The	Journ. des Débats, 17 Sept.; Colla.

	tenberg in Styria. In the counties of Neutra and Comorn only some very short slight shocks were felt.	rapidity that they could not be counted.		waters of the Mur were agitated and troubled, and threw a great many small fish up on the bank.	
1838. Sept. 14. 7 A.M., or, according to M. Colla, 9 A.M.	Adderbury in Oxfordshire.	A strong vibratory shock. The houses trembled for more than half a minute.	....	Accompanied by subterranean explosions. The sky looked stormy, but there was no thunder.	Journ. des Débats, 18 Sept.; Colla, Giorn. Astron. 1840, p. 110.
—— —— 27. The shocks continued for three-quarters of an hour, and the last occurred at 4^h 5^m A.M.	At sea, in 31° 40′ N. lat., and 44° 30′ W. long. (doubtless from Paris).	The first shock was the longest and most severe.	A violent shock, lasting thirty seconds, was felt on board *la Claudine* of Hâvre, followed by two others not quite so severe, separated by several slight ones of five or six secs. duration, very often repeated, and at intervals of about five minutes. The weather was clear and fine, and the sea nearly calm. No visible motion of the latter could be perceived.	The noise accompanying each shock was exactly that of distant thunder. The whole crew was roused and came on deck, thinking that the ship had struck.	Comptes Rendus de l'Acad. t. viii. p. 32; v. Leonhard, Taschenbuch für Freunde der Geologie, 1846. S. 210.
—— —— 29. About 1^h or 9^h 5^m P.M. (?)	Messina and the neighbourhood.	A strong undulatory shock.	....	To the west the shock was so severe that the inhabitants passed the night out of doors. On the 29th and 30th the eruption of Etna was more energetic than ever.	Journ. des Débats, 29 Oct.; Colla.
—— Night between Sept. 30 & Oct. 1.	Ditto	Ditto	....	....	Ditto.
—— Oct. 9. 2 P.M.	At sea, in 27° 37′ N. lat., and 31° 7′ W. long. (probably from Paris).	....	Three slight shocks felt on board *la Claudine*, vid. Sept. 27.	....	Authorities for Sept. 27.
—— —— 14. 7 A.M.	Coblentz	A violent and almost instantaneous shock.	....	From the 11th to the 14th the barometer had gone down from 28 in. 4·2 lines to 27 in. 6·6 lines (French ?). On the 13th a remark-	Journ. des Débats, 20 Oct.; Colla.

1.	2.	3.	4.	5.	6.
				able fall of the barometer at Parma, the wind being high and impetuous. On the 14th and 15th the temperature also fell considerably at the same place.	
1838. Oct. 17 to 22.	In the valley of Elsa, Tuscany.	The earth during this period was in a state of continuous agitation. By night the tremblings and by day the noises (rhombi) never ceased. Shocks like those of 1804 frequently recurred during the autumn.	....	But trifling damage done	Pilla.
—— —— 26. **4h 49m P.M.**	Avesnes in the departm. du Nord.	A very severe shock...	....	....	Colla, Giorn. Astron. 1840.
—— Nov. 26. At night.	At the chateau of Laupen in the canton of Berne.	Very slight subterranean commotion.	....	....	Ditto.
—— —— ...	Crieff in Scotland	A shock	....	....	Milne's Catalogue, *loc. cit.*
—— Dec. 7. 9h 10m P.M.	Zacuapan in Mexico ...	Direction N.N.W. to S.S.E.	....	Great numbers of shooting stars observed for several nights before.	Bull. de l'Acad. Roy. de Bruxelles, t. viii. pt. 2. p. 440.
—— —— 15. **Midnight.**	At Zurich	A slight shock........	....	....	Mérian.
—— —— 16.	In the departm. Isère...	During the period of slight shocks felt at St. Jean-de-Maurienne, earthquakes were also felt in this department. The most severe occurred on this day and on the 26th March following.	....	....	Mém. de Turin. 2 sér. t. ii. p. li.
—— —— 19. **10h 20m P.M.**	St. Jean-de-Maurienne in Savoy.	A very severe shock ..	....	....	Comptes Rendus de l'Institut, t. xv. p. 1217.
—— —— 23. **4 P.M.**	Woodhouse Eaves on Charnwood Forest, Leicestershire.	S.W. to N.E.	....	Preceded by a rumbling noise like that of a heavy waggon.	Gentleman's Magazine, N. S. vol. xi. pt. 1. p. 198.

1838. Dec. 23. **In the middle of the night.**	**La Rochelle**	**A rather severe shock, lasting half a second.**	....	**Accompanied by a noise like the report of a distant cannon. At several places in the department doors were violently shaken.**	**Journ. des Débats, 31 Déc.**
1839. Jan. 11. **5h 45m or 6 A.M.**	**Island of Martinique.** Also felt in Guadaloupe.	Very violent shocks, lasting 2 minutes; according to another account, two shocks, lasting 30 or 10 secs., apparently undulatory, and from S. to N. There were four other earthquakes before the 21th.	....	A very great number of buildings thrown down, and people killed thereby. The wind was N.W., and the island entirely enveloped in clouds and vapour, a state of the atmosphere very unusual at this season. (Perhaps this cloud may have arisen only from the falling houses, which are said to have sent up a vast cloud of dust.)	Gentleman's Magazine, N. S. vol. xi. pt. 1. p. 304; Comptes Rendus de l'Acad. t. viii. pp. 329, 364; Gazette de France, 27 Fév. et 30 Mars; Journ. des Débats, 8 Mars; Moniteur, 20 Fév., 8 Mars, et 4 Avril, &c.
—— —— 12. In the morning.	Berlin, particularly in the northern part of the city.	Very distinct shocks..	....	....	Moniteur, 23 Janv.; Colla, Giorn. Astron. 1841, p. 151.
—— —— 14. 9 P.M.	Suddeeah in Upper Assam.	Apparently from S.W. to N.E.	....	Preceded by rain and heavy snow in the mountains; the air very cold.	Quart. Journ. Geol. Soc. 1845. p. 142. quoting Journ. Asiat. Soc. of Bengal.
—— —— 17. 4h 45m A.M.	Milan	A shock *indicated* by the magnetic needle.	....	....	Colla.
—— —— — During the night (of 16–17 ?).	Salonica	Violent subterranean movements.	....	Several houses which before threatened to fall were ruined.	Ditto.
—— —— 21. 6 A.M.	Island of Sainte-Lucie in the West Indies. Also in Martinique.	Severe and prolonged shocks, lasting 35 seconds.	....	More damage done in Martinique..................	Journ. des Débats et Moniteur, 4 Avril; Colla, Giorn. Astron. 1841, p. 151.
—— —— —	St. Mary, one of the Scilly Isles.	A shock	....	....	Communication of M. Plieninger to M. Perrey.
—— Feb. Night between 7 & 8.	Near the village of Baklikli, 15 wersts west of Bakou in the Caucasus.	Violent subterranean commotions extended to the distance of 30 wersts.	....	Accompanying an eruption of flames and mud. The Moniteur of 16 Sept. 1840, gives the date Jan. 26–27 (O. S.?), 1840.	Colla, Giorn. Astron. 1841, p. 151; v. Humboldt, Asie Centrale, t. ii. p. 513.
—— —— 10. 8h 30m A.M.	Aigueperse, Riom, and Gannat, in the departm. Puy-de-Dôme.	A violent shock	....	....	Journ. des Débats, 24 Fév.; Moniteur, 25 Fév.; Colla.
—— —— 25. 7 A.M.	Borgotaro in Tuscany...	A very distinct shock.	....	Preceded by a very loud noise	Colla.
—— —— 27 to June 16.	St. Jean-de-Maurienne in Savoy, and the sur-	Forty-nine shocks were felt during this	....	Almost all of these shocks were accompanied or preceded by noises, variously compared to	Memoir of M. A. Billiet in Mém. de Turin, 2 sér. t. ii.; Comptes Ren-

1.	2.	3.	4.	5.	6.
	rounding district, including 32 communes. It was remarked that the left bank of the Arc was more severely shaken than the right.	period, of which nine were rather severe and the remainder moderate or slight, besides twenty or twenty-five scarcely perceptible, or local. Another observer reckoned seventy-four shocks. They lasted in general but a few seconds, often consisted of two or three very distinct successive oscillations, and were chiefly in the direction N.W. to S.E. at St. Jean-de-Maurienne. At. St. Sorlin-d'Arves and Fontcouverte they were supposed to come from the W., and at Albiez-le-Jeune from the S. or E.		those of a heavy carriage passing over pavement, a violent storm, an avalanche of snow, and distant thunder. This noise seemed to pass from N.W. to S.E., or W. to E. The more severe of these shocks produced cracks in walls in some of the communes, and articles of furniture were violently shaken about. During the principal shocks the atmosphere was obscured by a kind of fog or mist, which soon after dissipated itself. After the shock of the 26th March, which was the most severe, the hot springs of Maurienne increased in quantity of water, their temperature rose, and the water, usually limpid, was troubled. A carefully compiled catalogue of these shocks by M. Billiet is to be found in M. Perrey's 'Memoir on Earthquakes in the Basin of the Rhone,' p. 57. The summer of 1839 was remarkably dry in Savoy, no rain falling for eighty days, and scarcely any sign of atmospheric electricity manifesting itself; but in September extremely heavy rains set in, which produced inundations in many of the Swiss valleys.	dus, t. ix. p. 486; Journ. des Débats et Moniteur, 13, 14, 15 et 18 Mars.
1839. Mar. 12. 10 P.M.	Palermo	Two shocks, with an interval of some seconds.			Colla.
—— —— 17. 6h 15m and 7h 25m P.M.	In the Upper Engadine, Switzerland.	Shocks from N.W. to S.E.			Mérian.
—— —— 20. 3h 15m A.M. At Kingussie, between 2 & 3 A.M.	Glengarry in Inverness-shire.	Very severe shocks	The people in a canal boat felt the shock, and heard the noise reverberating among the hills.	Doors were lifted off the latches. The Moniteur and Colla give the date March 27.	D. Milne's Catalogue, *loc. cit.*; Moniteur, 5 Avril; Colla, Giorn. Astron. 1841, p. 153.

1839. Mar. 21 to April 1.	San Salvador-de-Guatemala.	Very violent shocks, especially on the 21st and 27th.		A mountain fell, burying beneath its ruins an entire village with all its inhabitants, and dammed up the course of a river. The earth opened, even in the town itself. The inhabitants fled to the open country to avoid being crushed under the walls which fell in all directions. The incessant agitation of the ground and terrible subterranean noises led them to expect the opening of a volcano.	Colla, Giorn. Astron. 1841, p. 153.
—— —— 22. In the morning.	In Styria	An earthquake			Lamont, Annalen für Meteorol. u. Erdmagn. 1842, Heft 1. S. 160.
—— —— 23. 2 A.M. According to Silliman's Journal, between 3 & 4.	Amurapoora and throughout the Burmese Empire, extending more than 1000 miles from N. to S.	Two violent shocks from E. to W. at the hour mentioned, followed by slighter ones up to 8 A.M., and feeble tremblings for a year after. The direction of the shocks is also given as N. to S., or *vice versâ*.		Preceded by loud rumbling noise. Huge fissures of 10 to 20 feet in width, and running from N. to S., opened in the ground, from which vast quantities of water and black sand were thrown out, flooding the plains. Volcanic eruptions on the same day in the hills to the south of Kyouk Phyoo.	Asiatic Journal, N. S. vol. xxix. pt. 2. p. 288; Silliman's Journal, vol. xxxviii. p. 385.
—— —— 26.	In the department of the Isère, in the canton of Oisans, at Allemont, Auris, &c.	Frequent shocks during the period of the earthquakes at St. Jean-de-Maurienne. The most severe were on the 16th Dec. 1838, and 26th March 1839 (the day of the most severe shock in Maurienne). The motion was from N.E. to S.W.		The shocks were always preceded by a noise like distant thunder or the fall of an avalanche.	Mém. de Turin, 2 sér. t. ii. p. li.
—— April 3. 6^h 30^m A.M.	Grenoble	A slight shock from E. to W., lasting 2 secs.			Colla, Giorn. Astron. 1841, p. 153.
—— —— 4.	St. Ambroise near Turin.	A shock			M. Billiet in Mém. de Turin, *loc. cit.*

1.	2.	3.	4.	5.	6.
1839. April 5. 5 P.M.	Florence	An undulatory shock from S. to N., followed by another of less intensity, which was again succeeded by a severe shock "en soubresaut." Total duration = 6 or 7 secs. At $6^h\ 45^m$ a very slight shock; at $9^h\ 30^m$ another; and two more during the night.		Preceded by a very loud noise, which lasted about 3 seconds. After the shocks the sky became clouded over, and in the evening very dense clouds formed in the N.W., extending in the form of stratus towards the S.E.	Colla; Lamont, Annalen für Meteor. u. Erdmagn. Heft 1. S. 160.
—— —— 7.	In Switzerland				M. Billiet in Mém. de Turin, *loc. cit.*
—— —— 8.	Frutigen in the canton of Berne.	A severe earthquake shock.			M. Studer's Catalogue.
—— —— 11.	Interlaken in the same canton.				Ditto.
—— —— 14. $2^h\ 5^m$ P.M.	At Algiers. Felt rather more strongly in the upper part of the town than in the lower part near the sea. Also strongly felt at Constantine, especially in the centre of the town.	A general vibration violently shook all the houses of the town. It lasted two or three seconds.	The shock was felt on board vessels in port.	Immediately preceded by a subterranean noise, in the direction S.E. to N.E. (?). Some already ruinous walls fell. At the moment of the shock the atmosphere was calm and the sky clear, with a very gentle breeze from the S.E. The preceding night there had been an extraordinary storm, which seemed to be confined to the lower strata of the atmosphere, and was accompanied and followed by abundant showers of hail. At Oran and Bona a terrible tempest, with a frightful sea, prevailed on the 11th, 12th, and 13th, but the earthquake was not perceived at either of these places.	Comptes Rendus de l'Acad. t. viii. p. 763; Journ. des Débats, 29 Avril.
—— May 8. Between 11 P.M. and midnight.	In the Bernese Oberland, and the Emmenthal, Switzerland.	A shock from N.W. to S.E.			Mérian.

1839. May 10. After midnight (of the 9th?)	Again in the Bernese Oberland.	Another shock			Ditto.
—— —— 11. At Jamulpoor, at $9^h\ 30^m$ A.M. At Comercolly, $9^h\ 50^m$; and at Sylhet, $9^h\ 55^m$.	Jamulpoor, Comercolly, and Sylhet, in North-eastern India.	Direction at Jamulpoor = W. to E., or N.W. to S.E.			Asiatic Journal, N. S. vol. xxx. pt. 2. p. 15.
—— —— 20.	In Calabria	Shocks			Lamont's Annalen für Meteor. u. Erdmagn. Heft 1. S. 160.
—— —— 22. 11 A.M.	Bridgewater in Scotland (Somersetshire?), and the country for sixteen miles round.	A very distinct shock			Moniteur, 30 Mai; Colla, Giorn. Astron. 1841, p. 154.
—— —— 24. 2 A.M.	Glasgow and environs, and Crieff in Scotland.	Two strong shocks, each of which lasted two seconds, at Crieff.		Accompanied by subterranean noise of much longer duration than the shocks. The weather at Crieff soft next day.	Ditto; Milne's Catalogue, *loc. cit.*
—— June 3. 8 P.M.	Suddeeah in Upper Assam.	Apparently from S. to N.		The season had been unusually wet from March up to this time. The small-pox was prevalent.	Quart. Journ. Geol. Soc. 1845, p. 142, quoting the Journ. Asiat. Soc. Bengal.
—— —— 7. 2 A.M.	Island of Meleda in the Adriatic.	Slight undulatory shocks from S. to N.		Preceded by a noise like an explosion	Colla.
—— —— 9. $6^h\ 36^m$ A.M.	Island of Antigua	Violent subterranean commotion, followed the next morning by a slight shock.		Followed by a violent tempest	Ditto, Giorn. Astron. 1841, p. 154.
—— —— 11.	North of Manchester	A shock			Milne's Catalogue, *loc. cit.*
—— —— —	In the mountains of Albano, near Rome.	Shocks			Lamont's Annalen für Meteorol. u. Erdmagn. Heft 1. S. 160.
—— —— 12. $8^h\ 15^m$ A.M.	In Lancashire, and especially north of Manchester.	A slight shock. According to M. Plieninger, several shocks in Lancashire.		Accompanied by noise like thunder. Doubtless the account given by Milne on the 11th refers to this event.	Colla, Giorn. Astron. 1841, p. 154; Communication of M. Plieninger to M. Perrey.
—— —— 16. 8 A.M.	Choapam in Mexico	A slight shock, from W. to E. (?).		Many shooting stars were observed about the time (in June).	Bull. de l'Acad. Roy. de Bruxelles, t. viii. pt. 2. p. 441.

1.	2.	3.	3.	5.	6.
1839. June 29. About 4 P.M.	Sagorbe in Valencia, Spain.	A shock of two seconds' duration.		Accompanied by subterranean and distant rolling noise.	Moniteur, 15 Juillet.
— July 13. 9 A.M.	Oaxaca in Mexico	No distinct shocks, but a very violent undulatory motion, from S. 10° W. to N. (!). Lasted one to two minutes.		Many shooting stars observed on the 10th	Bull. de l'Acad. Roy. de Bruxelles, t. viii. pt. 2. p. 441.
— Aug. 2. 2h 25m A.M.	Island of Martinique	Three severe shocks of twelve or fifteen seconds' duration. The motion was sharp, jerking, and horizontal from N.E. to S.W.		The weather had been dry since the earthquake of the 11th of January, but the rain began immediately after this one, during suffocating heat.	Colla, Giorn. Astron. 1841, p. 154; Comptes Rendus, t. ix. p. 415; Moniteur, 12 Sept.; Journ. des Débats, 27 Sept.
— — 7. 8 A.M.	Annecy in Savoy	A slight shock			Colla, Giorn. Astron. 1841, p. 155; M. Billiet, *loc. cit.*
— — — About 2h 20m P.M.	Lucca	A strong undulatory shock, from N.W. to S.E., lasting three seconds.			Colla.
— — 8. 3h 30m and 10h P.M.	Annecy in Savoy	Two more shocks; slight.			Colla and M. Billiet, *loc. cit.*
— — 9. 8 A.M.	Ditto	Another slight shock			Ditto.
— — — 9h 30m A.M.	Brescia	A very severe shock		Many persons were suffocated in the crowd which rushed out of the Église des Miracles.	Colla.
— — 11. 8 P.M.	Annecy in Savoy	A severe shock			Colla and M. Billiet, *loc. cit.*
— — 16. 6h 30m P.M.	Ditto. (On the same evening a slight shock at Geneva.)	Ditto		Preceded almost immediately, as were all the shocks of the preceding days, by a subterranean noise like a loud clap of thunder. On this day and on the 11th a great number of chimneys were thrown down.	Ditto.
— — 18. 8 A.M.	Irkutsk in Siberia	Three shocks, one of which was severe enough to throw			Colla, Giorn. Astron. 1841, p. 155.

		motion came from the N.W.			
1839. Aug. 27. About noon.	Reggio in Calabria	A very severe shock, lasting about six seconds.	....	....	Colla; Lamont's Annalen für Meteorol. u. Erdmagn. Heft 1. S. 160; Journ. des Débats, 18 Sept.; Moniteur, 19 Sept.
—— —— — 1ʰ and some minutes P.M.	Messina	A shock, followed by two others at 5 and 8 P.M., and by a third, of two seconds' duration, at 9ʰ 30ᵐ. "Mouvement par soubresauts." Three minutes afterwards another slight shock. Direction of the shocks = S.E. to N. (?).	....	Accompanied by a noise like that of a strong wind. At the moment of the shocks the air assumed a reddish or roseate tinge, as was observed at Parma on the 12th and 13th of March 1832. The wind blew steadily from the N.W.	Ditto.
—— —— —	Annecy in Savoy. None of the shocks recorded at this place were felt in Maurienne.	Two more shocks ...	....	....	Colla and M. Billiet, *loc. cit.*
—— —— 28 and 29.	Messina and Reggio ...	Three more shocks. That on the 28th at 5ʰ 30ᵐ (A.M. or P.M.?) was the most severe.	....	....	Authorities for the shocks at Messina on the 27th.
—— —— 30 and 31.	Ditto	Two more shocks ...	....	....	Ditto.
—— Sept. 2. 1 A.M.	Bristol, Newport, Cardiff, and other places in S. Wales, and at Shrewsbury. Felt most at Kingsdown.	A very severe shock ..	....	East of Bristol, beds rocked, crockery was thrown down, and doors were opened. M. Plieninger gives an earthquake as felt in Monmouthshire and all the West of England on the 8th at 1 A.M., but the date is no doubt erroneous.	Colla, Giorn, Astron. 1841, p. 156; Lamont's Annalen, Heft 1. S. 160; Milne's Catalogue, *loc. cit.*
—— —— 10. At night.	In a great part of Monmouthshire.	A severe shock of some seconds' duration.	....	Followed by a loud explosion. Probably only the same event as that recorded on the 2nd.	Colla, *loc. cit.*; Lamont's Annalen, *loc. cit.*

1.	2.	3.	4.	5.	6.
1839. Sept. Night between 20 and 21.	Island of Martinique ..	A slight shock........	....	....	Colla, *loc. cit.*; Quételet, 2e Mémoire sur les Etoiles Filantes, p. 57.
—— —— 23.	Island of Jamaica	An earthquake shock	....	....	Ditto.
—— After the autumn equinox. Between 7 and 8 P.M.	Kingston in Jamaica ...	A severe shock	....	Accompanied by noise like distant thunder. Perhaps this account refers to the event of the 23rd of September.	Colla, *loc. cit.*
—— Oct. Night between 1 and 2.	San-Salvador-de-Guatemala.	A formidable earthquake. Forty-eight shocks were counted in twenty-four hours, and others followed on the ensuing days up to the 10th.	....	All the buildings were seriously injured, and some entirely thrown down. Most of the inhabitants fled to the open country. The town was rendered uninhabitable.	Ditto.
—— —— 4 to Dec. 28.	St. Jean-de-Maurienne in Savoy, and the surrounding district.	During this period forty-nine principal shocks were felt, and many more indistinct ones which were not recorded. They generally occurred in groups, several at a time. M. Colla reckons forty from the 6th to the 28th December, of which four were severe, twelve moderate, and twenty-four slight.	....	From the 16th June to the 4th October the shocks had ceased at St. Jean-de-Maurienne, but they now began again. The list of individual shocks by M. A. Billiet is given in Perrey's 'Memoir on Earthquakes in the Basin of the Rhone,' p. 61. They were generally preceded or accompanied by subterranean noise, and sometimes this noise was heard without any sensible shock. After the shock of the 11th December, at $3^h\ 25^m$ A.M., about two minutes later, the horizon appeared brilliantly lighted, so that one could easily distinguish the objects in a room.	Memoir of M. A. Billiet, *loc. cit.*; Colla, Giorn. Astron. 1841, p. 157.
—— —— 17. $10^h\ 25^m$ P.M.	Gratz in Styria	Violent shocks, from S.W. to N.E., lasting 4 secs.	....	....	Colla, *loc. cit.* p. 156; Lamont's Annalen, *loc. cit.*
—— —— 21 and 22.	Island of Antigua	Prolonged but very slight undulatory shocks.	....	....	Colla, *loc. cit.* p. 156; Lamont's Annalen, Heft 1, S. 161.

to 26.		ring the period mentioned, twenty-six of which were severe, the others moderate or slight.		loud and prolonged noise.	
—— —— 22.	Smyrna ……………………	A rather severe shock.	…………………………	………………………………………………………	Ditto.
—— —— 23. Throughout the whole region affected the shock seems to have been felt simultaneously, viz. at about 10^h 30^m P.M.	Felt throughout two-thirds of Scotland. The southern limit nearly coincided with a line drawn from the Solway to the mouth of the Tweed, and the northern limit as nearly coincided with the course of the Caledonian Canal.	The intensity varied very much at different places, and was greatest at Comrie in Perthshire. The lines of equal intensity are said to have nearly formed ellipses, of which Comrie was the centre, and of which the longer diameter ran N.E. and S.W., or parallel to the Grampian chain. In and near Comrie there were several distinct undulations, apparently from W. to E. or N.W. to S.E., followed by a trembling or vibratory motion. In more distant places only this trembling was felt. Different persons supposed the ground to be raised from 2 to 6 or 8 inches. The angle made by the wave with the horizon appeared to be at	The river Earn is said to have appeared to stand still for an instant during some of the shocks. Water in some other places was also seen in a state of agitation.	Accompanied by a very loud noise, variously spoken of as subterranean and aërial, and compared to the loudest thunder, artillery, the blowing up of a magazine, wind amongst the trees, &c. This noise lasted 20 or 30 secs. One person observed the branches of some trees all bent towards the east, as if a strong gale were blowing on them. After they had recovered their erect position not a leaf stirred, but during the time a hollow *sugh* was heard in the air like the draught of a furnace; this continued about 20 secs. after the concussion. At Comrie greater injury of walls, displacement of furniture, and other similar effects were produced than in other parts of the country. On the following day a strange black scum was found on the ground. A similar phænomenon had been remarked several times before on Loch Earn, and occurred again in February and March 1841. A strange kind of sulphurous odour is said to have been perceived in some places, and several persons experienced a feeling of nausea. An electrical discharge was supposed to take place at the time of the shock. Aurora borealis and shooting stars were more frequent than usual in September and October. The weather was very wet, and the barometer, already low, fell for some hours before the shock.	D. Milne in Jameson's Edinburgh New Philosophical Journal, vol. xxxv. p. 137; *Vide* also other vols. referred to below.

1.	2.	3.	4.	5.	6.
		Alloa 1° 18′, and in the Carse of Falkirk 3° 47′. The shock seemed to be perpendicular at Comrie. Others appear to have occurred at some places within an hour or two after.			
1839. Oct. ...	Comrie in Perthshire ...	Shocks were felt on Oct. 3, 7, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19 to 22, 23, 24, 25, 26, 27, 28, 29, 30 and 31. The principal one, the most severe of all those felt at Comrie, was on the 23rd of this month, at 10ʰ 30ᵐ P.M. The character of the shocks was sometimes that of a sudden sharp blow, sometimes undulatory, and sometimes vibratory or tremulous. The direction of the whole series of shocks at Comrie seems to have been most generally E. and W., or N.E. and S.W.		The long-continued series of slight shocks felt at Comrie which here commence have been carefully recorded by Mr. Milne, and it is on his authority, and that of the Reports to the British Association, that the dates and other particulars are given in this Catalogue, from which other accounts occasionally differ. As the shocks were generally of so local and slight a character, they are only noticed once at the end of each month in which they occurred; the separate notice of each shock would give them undue importance in a general catalogue of earthquakes. The shocks were in general very slight, but sometimes rather severe; and were generally accompanied by subterranean noises, variously described as like distant thunder, the reports of artillery, the sound of a rushing wind, &c. The noise sometimes seemed to be in the air, and was often heard without any sensible shock at the time. Several shocks were often felt each day. The shocks were generally felt further N.E. and S.W. of Comrie than in any other direction. In one house of the town, built on a rock, they were much less felt than in any other in the neighbourhood. The weather was generally wet and drizzly, and the rivers were frequently and suddenly flooded. A thin fleecy cloud was often observed hovering over the	Papers by D. Milne in Jameson's Edinburgh New Philosophical Journal, vols. xxxii. xxxiii. xxxiv. xxxv. and xxxvi.; Philosophical Magazine, vol. xx. p. 242; British Association Reports, 1841, 1842, 1843, and 1844; M. Perrey's Catalogue of Earthquakes in the British Islands, quoting chiefly communications from Mr. Macfarlane of Comrie.

				Lednock valley, which was considered to be the centre of disturbance. The shocks were on the whole most numerous and severe in the month of October. There does not seem to have been any connexion between those at Comrie and those occurring this year at St. Jean-de-Maurienne in Savoy.	
1839. Nov. 2. About 4 P.M.	Geneva	A slight shock. Some instants after, a strong shock felt at Sión.			Colla, Giorn. Astron. 1841, p. 157.
—— —— 3. 2 A.M.	Sion in the Valais	Another rather strong shock.			Ditto.
—— —— 8. 3 A.M.	Coire in the Grisons	A shock from S.W. to N.E.			Mérian.
—— —— 25.	Rome	A vibratory shock			Quételet, 2 Mém. sur les Étoiles filantes, p. 57.
—— —— ...	Comrie in Perthshire	Shocks were felt on Nov. 1, 2 to 8, 9, 19 to 28, 29 and 30.			Authorities for October.
—— Dec. 11. Before 1 A.M.	Zürich	A vibratory shock			Mérian.
—— —— 17. 6 A.M.	Berne				Ditto.
—— —— 24.	On the coast of Dorsetshire.	A strong vibration		Attended by a sinking of the ground (landslip?).	Communication of M. Plieninger to M. Perrey.
—— —— ...	Comrie in Perthshire	Shocks on Dec. 2, 3, 4, 5, 6, 7, 8, 11, 12, 13 to 18, 20, 24, 28 and 31.			Authorities for October.
1840. Jan. 2 to March 18.	St. Jean-de-Maurienne in Savoy, and the surrounding district.	The shocks still continued in this district. Ten were felt during the period mentioned, two of which were of moderate intensity, and all the others slight.		The list of days on which these shocks occurred is given by M. Perrey in his 'Memoir on Earthquakes in the Basin of the Rhone.'	Memoir of M. A. Billiet, *loc. cit.*
—— —— 5. A little before midnight.	In the Pyrenees	An earthquake		Chimneys were thrown down. Four days before, a strong smell of sulphur had been perceived, accompanied by subterranean noise, at Bagnères de Bigorre.	Moniteur, 12 Janv.; Colla, Ann. Astron. 1841; Écho du Monde Sav. No. 509.

1.	2.	3.	4.	5.	6.
1840. Jan. 8. About 10 P.M.	In the northern part of Co. Donegal, Ireland. Principally felt in the barony of Innishowen.	A very distinct vibration, compared to that produced by the passing of a loaded cart. Lasted about 20 secs. Apparently from E. to W., or N.E. to S.W.	....	Accompanied by a noise which seemed to be on the surface of the earth or immediately beneath it, like thunder or the firing of cannon, and lasting 1 to 3 secs. In another place a crackling sound was heard in the air. The night was beautifully clear and fine. Windows were made to rattle, and some flags in a kitchen floor were moved from their places, but buildings were not injured. The noise was heard as far as the parish of Cloncha, 20 miles north of Londonderry.	Mr. Milne in Jameson's Edinburgh New Philosophical Journal, vol. xxxvi. p. 72.
—— —— ——	Lucey on the Rhone ...	A slight shock........	....	....	Journ. des Débats, 22 Janv.
—— —— 14.	Island of Meleda in the Adriatic.	A vibration	....	....	Colla.
—— —— 16. 11h 40m P.M.	Island of Martinique ...	Three rather smart shocks, the motion quick and jerking, with horizontal oscillations from N.E. to S.W. Duration, 3 secs.	....	....	Moniteur, 31 Mars, 1841; Lamont's Annalen für Meteorol. u. Erdmagn. Heft 1. S. 161; Écho du Monde Sav. No. 527; Colla, Giorn. Astron. 1842, p. 90.
—— —— 17. 6h 30m A.M.	Ditto	Another shock	....	....	Ditto.
—— —— ——	Trieste, Goritz, and Milan.	An earthquake shock.	....	....	Quételet, 2 Mém. sur les Étoiles filantes, p. 57; Gazette de France, 30 Janv.
—— —— 18.	In Croatia	An earthquake........	....	....	Communication of M. Colla to M. Perrey.
—— —— 19.	In the Pyrenees	More shocks	....	....	Colla, Giorn. Astron. 1842.
—— —— 20.	Lisbon	An earthquake.........	....	....	Ditto, p. 90; Quételet, Ann. de l'Observ. Roy. de Bruxelles, 1843, p. 285.
—— —— 22.	In the islands of Sara and Linkoro in the Caspian Sea.	Shocks..................	....	....	Colla; Plieninger, Jahrsbericht über die Witterungs-Verhältnisse in Würtemberg.
—— —— 24. Between 2 and 3 A.M.	Petit-Huningue near Bâle. Some persons said they felt this shock in Bâle itself.	Rather a strong shock.	....	During a severe tempest, "which makes the account doubtful."	Mérian.

1840. Jan. 23.	Clagenfurth in Carinthia.	A shock of earthquake.			Communication of Signor Colla to M. Perrey.
—— —— 26.	In Silesia	Shocks		During a tempest	Plieninger, Jahrsbericht über die Witterungs-Verhältnisse in Würtemberg.
—— —— 31. Some minutes before 8 P.M.	Parma and Guastalla	A slight undulatory shock, from S.E. to N.W.			Colla.
—— —— ...	Comrie in Perthshire	Shocks were felt on Jan. 2, 4, 8, 11, 18, 19, 20 and 27.		The weather still very wet	Authorities for October 1839.
—— Feb. 1 and 2.	Guastalla in Northern Italy.	Slight shocks			Colla.
—— —— 14. At night.	Island of Ternate	Exceedingly violent		Preceded by a volcanic eruption on the 2nd.	Asiatic Journal, N.S. vol. xxvii. pt. 2. p. 325.
—— —— Night between 19 and 20.	Guastalla in Italy	Slight shocks again			Colla; Gazette Piém. 20 Mars.
—— —— 26. At night.	Cabul	Undulatory shock, lasting about five minutes, preceded and followed by several slighter ones.			Asiatic Journal, N. S. vol. xxxii. pt. 2. p. 104.
—— —— 29. About 2h 15m A.M.	Parma, and, at the same instant, at Lucca.	At Parma, two slight undulatory shocks in the space of a minute. Direction indicated by the seismograph of the observatory — S.E. to N.W. At Lucca a sharp jerking shock, very severe.			Colla; Gazette Piém. 20 Mars.
—— —— ——	Smyrna	An earthquake shock.			Colla.
—— —— ...	Comrie in Perthshire	Shocks on Feb. 6, 9, 10, 14, 25 and 26.			Authorities for October 1839.
—— Mar. 4. 1 P.M.	Suddeeah in Upper Assam.	Apparently from the S. Followed by a second shock after an interval of ten minutes.		Preceded by a total eclipse of the sun about an hour before, during which the air was unusually cold, and disagreeable even to nausea.	Quart. Journ. Geol. Soc. 1845. p. 142, quoting Journ. Asiat. Soc. of Bengal.

1.	2.	3.	4.	5.	6.
1840. Mar. 10. At night.	Meyringen in the canton of Berne, Switzerland.	A slight shock			Mérian; Quételet, Ann. de l'Observ. de Bruxelles, 1843.
—— 12. Between 11 P.M. and midnight.	Ditto	Two severe shocks from S.E. to N.W., followed by a slight one a quarter of an hour later.		The Allgemeine Schweizer Zeitung and M. Studer's Catalogue give the date as the night between the 13th and 14th, 1 A.M.	Ditto.
—— 13.	Berne			Perhaps only the same with the last. On the 11th, 12th, and 13th, there were storms in the kingdom of Naples; and on the 14th and 15th magnetic disturbances at Prague, and on the 15th at Milan.	Communication of M. Colla to M. Perrey.
—— ... Night between 16 & 17. About midnight.	Messina	A distinct shock. Followed by a slighter one at 4 A.M.			Colla.
—— 22. 4h 17m P.M. (At Guérande, 3h 30m).	Nantes, Guérande, and some of the district to the west, departm. Loire-Inférieure.	At Nantes two shocks, separated by an inappreciable interval. At Guérande, a shock from E. to W.			Moniteur, 28 Mars.
—— —— 8h 15m P.M.	Annecy in Savoy. Not felt in Maurienne.	A rather severe shock.		On the 22nd and 23rd, a magnetic perturbation at Prague.	Memoire of M. A. Billiet, *loc. cit.*; Colla, *loc. cit.* 1842, p. 91.
—— 23. At night.	Ammerapoora, Ava, Tarquin (?), and many neighbouring villages, Burmah.	A violent earthquake. Lasted two or three minutes at Ammerapoora.		The cities and villages are said to have been almost destroyed and about 300 persons killed.	Edinburgh New Phil. Journ. vol. xxxvi. p. 364.
—— ...	Comrie in Perthshire ...	Shocks felt on March 8, 9, 11, 13, 14, 21, 24, 25, and 27.			Authorities for October 1839.
—— April 5.	Montrond near St. Jean-de-Maurienne, Savoy.	Two shocks. They became weaker as they passed from E. to W.		At Lyons, Roquemaure, and Perpignan, a violent thunder-storm on this day.	'Notes Additionnelles' to M. Perrey's Memoir on Earthquakes in the Basin of the Rhone, p. 21.
—— 25. Between 10 & 11 P.M.	Skrawinka in Austrian Poland. Felt also at Vagel and Kestern.	Three shocks in two minutes.			Communication of Sig. Colla to M. Perrey; Lamont's Annalen für Meteorol. u. Erdmagn. 1 Heft, S. 161.

1840. Apr. 26.	*Altendorf (in Bavaria, or Switzerland?).*				Authorities quoted above (on the 25th of March).
—— —— 30.	In the Carpathian Mountains.				Ditto.
—— —— ...	Comrie in Perthshire ...	Shocks felt on April 1, 7, 11, 12, and 13.		The shock of the 7th was strongly felt at Crieff.	Authorities for Oct. 1839.
—— May 2.	In Dalmatia	A shock of earthquake			Quételet, Ann. de l'Observ. Roy. de Bruxelles, 1843.
—— —— ...	Comrie in Perthshire ...	Shocks on the 19th and 22nd of the month.			Authorities for Oct. 1839.
—— June 3. 5^h 20^m A.M.	St. Jean-de-Maurienne in Savoy.	A rather severe shock, apparently the last of the long series at this place.			Communication of M. A. Billiet to M. Perrey.
—— —— 8.	Tours and Candes in the department Indre-et-Loire.	A vibratory shock ...			Lamont's Annalen für Meteorol. u. Erdmagn. 1 Heft, S. 161.
—— —— 11.	Athens	Ditto			Colla.
—— —— 20 to July 28 (O.S.). 6^h 45^m P.M. At Tiflis, at 7^h 10^m (P.M.?). At Erivan, at 7^h 30^m.	The whole district of Mount Ararat in Armenia.	A series of violent earthquakes at intervals during this period. They afterwards diminished in force, but did not entirely cease in the district of Sharar until September 1. The most severe shocks were on the 20th of June. They were frequent but intermittent, and lasted about two minutes. Followed by others from the 21st to the 28th.		In a few moments the whole aspect of the country in the neighbourhood of Mount Ararat was changed. The shocks gave the earth a movement resembling waves. Numerous fissures opened, all parallel to the rivers Araxes and Arpatchai; the earth was ploughed up to the distance of a werst from the beds of the rivers, and the fissures *were seen to open and shut every moment in accordance with the motion of the earth.* There occurred also a great number of vertical explosions from the bottom of holes like little craters, which, opening and closing like the fissures, cast up immense quantities of water mixed with sand and gravel. Numbers of the springs were dried up for some time, and continued for several days after to yield only thick and whitish coloured water; others became more abundant than they had been. The first four and most formidable shocks were accompanied by a subterranean noise. Numbers of buildings were cracked and so much injured that they fell on the oc-	Edinburgh New Philos. Journ. vol. xxxvi. p. 364; Moniteur, 25 Sept., 8 Oct., 23 Nov.; Phalange, 30 Sept.; Majocchi, Annali di Fisica, &c. t. viii. p. 292; Lamont's Annalen, 1 Heft, S. 161.

1.	2.	3.	4.	5.	6.
				currence of the subsequent shocks. Great damage was done by landslips from Mount Ararat, large masses of rock. ice and snow descending upon the valleys below.	
1840. July 2. (O.S. or N.S.?) At sunset.	The whole district of Mount Ararat in Armenia.	Lasted about a minute.		Vast masses of rock were thrown down from the mountains. Probably given according to New Style, and referring to the event of June 20, Old Style. M. Plieninger gives this date also, and states the hour as $6^h 45^m$ P.M. He says many houses were thrown down at Nachitschewan, and that some damage was done at Schuscha, but at $8^h 6^m$.	Asiatic Journal, N. S. vol. xxxiv. pt. 2. p. 120.
—— —— 7.	Island of Bourbon in the Indian Ocean.	An earthquake			Lamont's Annalen, 1 Heft, S. 161.
—— —— 14. O.S. 3 A.M. At Tiflis, at 2 A.M.	District of Mount Ararat. Felt at Tiflis and Erivan.	Another violent shock.			Authorities for June 20.
—— —— 15. In the morning.	Naples	A slight shock		A loud subterranean explosion was heard at the same time proceeding from Vesuvius.	Colla.
—— —— — (27 N.S.) About 7 P.M.	District of Mount Ararat.	Another of the violent earthquakes felt in this district. Lasted about a minute.		Terrible damage was done by the fall of a great mass of stones, ice, and melted snow from the mountain. Several of these great slippages seem to have taken place about this time, and devastated the country over a large area. 3000 houses were thrown down in the district of Schavour. Houses also fell in many other places, rocks were thrown down from the mountains, and many persons lost their lives.	Authorities for June 20.
—— —— 25. O.S. 3 and 10 A.M., and 5 P.M.	Ditto	More of these violent shocks.			Ditto.
—— —— 28.	Tiflis	Another shock			Memoir on Earthquakes in the Caucasus by M. Philadelphine of Tiflis, quoted by M. Perrey.

1840. July 29. $11^h\ 45^m$ P.M.	In the valley of Aosta, at Chatillon, Piedmont.	A shock of three or four seconds' duration.			Colla.
—— —— 30. (O.S. or N.S.?)	District of Mount Ararat. Extended as far as Tiflis.	Two severe shocks more.			Authorities for June 20.
—— —— 31. O.S. 3 A.M.	Tiflis				Memoir by M. Philadelphine above quoted.
—— —— ...	Comrie in Perthshire ...	Shocks were noted on July 3, 11, 16, 17, and 23.			Authorities for Oct. 1839.
—— Aug. 2. (O.S. or N.S.?) 7 P.M.	In the Khanate of Talschyn, district of Mt. Ararat. Felt at Tiflis and Alexandropol.	Several shocks in one minute. The shocks continued, though but slightly, up to the 8th.		No damage done. On the 6th another landslip from Mount Ararat took place, which did terrible mischief, the immense masses of rock, ice, and melted snow destroying or injuring numbers of houses, and leaving no trace of fields or gardens for a space of twenty wersts. The dates of these earthquakes of Mount Ararat are very confusedly reported, chiefly owing to the difference of style.	Authorities for June 20.
—— —— 9.	Connecticut and the neighbouring states. Felt at Hartford, Milford, Newhaven, Bridgeport, Derby, Waterbury, Middlebury, Woodbury; in Massachusetts, but not at Wertfield or north of Lichfield. More strongly felt at Washington, very severe at Worcester, slight at Middleton, and not at all felt at Boston.	At Chester there were fifteen or twenty shocks reckoned. in the direction N.W. to S.W. (?). Duration, half a minute.		Accompanied by a loud rumbling noise like thunder or that of a carriage. It seemed to pass from E. to W., or according to others, from N.E. to S.W., or N.W. to S.E. The atmosphere was very severe and bright.	Silliman's Journal, vol. xxxix. p.335; Trumbull's History of Connecticut, vol. ii. p. 92.
—— —— 27. $0^h\ 52^m$ P.M.	In Styria, Illyria, and Lombardy.	In Styria an undulatory shock from S. to N. At Venice a very distinct shock, lasting 5 secs., undulatory, from S. to N.		In Styria much damage was done. Therm. at Venice 24°·9 C. Bar. 28 in. 4 lines (French). The atmosphere was partly obscured by mist.	Communication of M. Colla to M. Perrey.

1.	2.	3.	4.	5.	6.
1840. Aug. ...	Comrie in Perthshire ...	Shocks on the 5th and 6th.	....	....	Authorities for Oct. 1839.
—— Sept. 2. 8^h 15^m P.M.	Roquemaure in Languedoc. Also felt at Châteauneuf, Cadérousse, Montfaucon, St. Géniès, Tavel, and Sauveterre.	Two shocks, from E. to W., with an interval of five minutes.	....	Accompanied by loud subterranean explosions. Some marshes on the banks of the Rhone disengaged abundance of inflamed gases.	Moniteur, 12 Sept.; Voleur, 18 Sept.; Colla.
—— —— 6.	Port-au-Prince in St. Domingo.	....	....	....	Gaz. de Milan, 26 Juin, 1841.
—— —— 10.	Hamilton in Upper Canada.	A violent shock. The oscillations appeared to pass from W. to E.	Pieces of water were violently agitated as if by a storm.	Accompanied by loud subterranean noise. Buildings were violently shaken.	Moniteur, 19 Oct.; Gaz. de France, 19 Oct.; Phalange, 23 Oct.; Colla; Giorn. Astron. 1842. p. 93.
—— —— 19.	Different places in the kingdom of Naples. Felt at Sora, Chieti, the whole of the Abruzzo Citeriore, and especially in the district round Monte-Majella.	Shocks which recurred for several days. During the night, two were felt at Sulmona, one consisting of a sharp blow, the other undulatory.	....	Accompanied by a dull noise........................	Colla; Lamont's Annalen, *loc. cit.*
—— —— ...	Comrie in Perthshire ...	Shocks on the 19th, 21st, and 26th.	....	....	Authorities for Oct. 1839.
—— Oct. 18 & 19.	Ferrières in the territory of Parma.	Very distinct shocks..	....	....	Colla.
—— —— 19.	Near Mitterfels in Bavaria.	An earthquake	....	The same day, magnetic perturbations at Parma, Munich, Prague, Milan, and Brussels. An aurora borealis was seen at Parma and in France. An extraordinary fall of the barometer took place in many parts of Europe.	Quételet, Annuaire, 1843, p. 290; Lamont's Annalen, *loc. cit.*
—— —— 27. About 9 P.M.	S^{te} Foy-les-Lyon	A slight shock *felt by some people.*	....	After a violent tempest at Lyons, which began about 7 and ceased about 9 P.M. The weather was terrible at Toulon, Marseilles, &c.	"Notes additionnelles" to M. Perrey's Memoir on Earthquakes in the Basin of the Rhone, p. 21.
—— —— 28 to 30. On the 30th, in the middle of the day.	Island of Zante	Violent shocks, especially on the 30th. Followed in the course of a week by about 100 shocks.	The Lord High Commissioner, who was in a steamboat at the time, and within six miles of land,	"The buildings which had their foundations on limestone escaped pretty well, except one village which was turned topsy-turvy; the stratum underneath showed itself betwixt the lime formation, to be full of large veins of	Edinburgh New Philos. Journ. vol. xxxvi. p. 365; Phalange, 27 Nov. et 2 Déc.; Lamont's Annalen, *loc. cit.*; v. Leonhard's Taschenbuch u.s.w. 1 Jahrgang, S. 208; In-

			boiler had burst.	structive of buildings ever felt in Zante.	
1840. Oct. 31. After midnight of the 30th.	Altnau in Thurgovia …	A strong shock, which wakened many people.	……………………	On the 29th an aurora borealis was seen at Brussels. On the 1st of November, magnetic disturbances at Prague, and on the 1st and 2nd at Munich.	Mérian; Quételet, Annuaire, 1843.
—— —— …	Comrie in Perthshire …	Shocks recorded on the 4th, 20th, and 26th. The shock of the 26th moved the instruments, by which vertical motion to the extent of half or three-quarters of an inch, and horizontal motion towards W. by N. to the extent of half an inch, seemed to be indicated.	……………………	……………………	Authorities for October 1839.
—— Nov. 5.	Various places in Calabria	……………………	……………………	……………………	Colla; Écho du Monde Sav, Nr. 587.
—— —— 6. 3 A.M.	In the Saxon Voigtland. Felt at Aarau.	Shocks. At Brambach there were three, rapidly succeeding each other, from N.W. to S.E. Followed at 1h 20m P.M. by another shock, of greater intensity, and in the same direction. At 6 P.M. there was another, very severe; and several slight ones occurred during the following night.	……………………	Accompanied by noise like thunder ……………	Lamont's Annalen, *loc. cit.*; Communication of M. Plieninger to M. Perrey.
—— —— 8. 6h 53m A.M.	Bessas and Barjac in the departm. Gard.	A rather violent shock, from N.W. to S.E., followed by two oscillations.	……………………	……………………	Quotidienne, 18 Nov.; Phalange, 22 Nov.; Colla, Giorn. Astron.

1.	2.	3.	4.	5.	6.
1840. Nov. 11. At night.	Philadelphia	A severe shock	Accompanied by a great and unusually sudden swell in the Delaware.		Edinburgh New Philos. Journ. vol. xxxvi. p. 365.
—— —— 14. 9 P.M.	Newhaven in Connecticut.	A shock		Accompanied by noise	Silliman's Journal, vol. xl. p. 376.
—— —— 25. O.S. About 6 P.M.	Nachitchewan in Armenia, and the neighbouring districts.	A vibratory shock, which lasted forty seconds.		No damage done	Quételet, Annuaire, 1843; Plieninger, Jahrsbericht uber die Witterungs-Verhältnisse in Wurtemberg.
—— —— 26 and 27.	Ditto	Two more shocks, slight.			Plieninger, *loc. cit.*
—— —— 29.	Ditto. More violent in the circle of Scharus.	The oscillations recurred more or less slightly up to December 7, O.S.		Houses were thrown down in the circle of Scharus.	Ditto.
—— —— ...	Comrie in Perthshire ...	Shocks were felt on November 12, 13, 16, and 21.			Authorities for October 1839.
—— Dec. Night between 9 and 10.	Belley in the departm. Ain. Felt in several communes on the banks of the Rhone.	A rather violent shock		No damage done	Moniteur et Gaz. de France, 19 Déc.; Phalange, 23 Déc.; Gaz. Piém. 14 Déc.; Colla, Giorn. Astr.
—— —— 10. $4^h 18^m$ A.M.	Chambéry in Savoy ...	A strong shock from E. to W.		Probably the same with the last. It is remarked that shocks had been pretty frequent in the sub-alpine regions for fifteen years before.	Ditto.
—— —— 25. $1^h 24^m$ A.M.	On the eastern shore of the Black Sea.	An earthquake shock			Lamont's Annalen, *loc. cit.*
—— —— — $6^h 37^m$ P.M.	Clagenfurth in Carinthia. Also felt at Ferlach in Swabia.	A shock, from S.W. to N.E., lasting two or three seconds.		Accompanied by noise like the rolling of a carriage.	Moniteur, 17 Janv. 1841.
—— —— 27. $6^h 30^m$ A.M.	Cosenza in Calabria ...	A severe shock, lasting about fifteen minutes (?).			Phalange, 27 Janv. 1841; Lamont's Annalen, *loc. cit.*
—— —— 31.	Smyrna, and Pyrgos in the Peloponnesus.	A violent shock			Gaz. Piém. 26 Janv. 1841; Lamont's Annalen, *loc. cit.*
—— —— ...	Comrie in Perthshire ...	Shocks noticed on December 6, 7, 8, 10 or 11, and 18.			Authorities for October 1839.

1841. Jan. 3. 6 P.M. and again at night.	Reggio and various other places in the Calabrias.	At Messina the first shocks were violent. Direction = N.E. to S.W. The shocks came from the Calabrias, and not from Etna.	....	....	Colla; Lamont's Annalen, *loc. cit.*; Moniteur, 19 Janv. 2 et 4 Fév.; Phalange, 20 Janv.
—— —— 4.	Ditto	More shocks	....	....	Ditto.
—— —— 6.	Ditto	Ditto	....	....	Ditto.
—— —— 15. In the morning and at noon.	At Algiers	Shocks at these hours	....	....	Lamont's Annalen, 1842. S. 161; Colla, Not. Météor.
—— —— 21. About 2 A.M.	Malta	A distinct but only momentary shock.	....	....	Colla.
—— —— 25. In the morning.	In the State of New York.	Shocks which lasted fifteen or twenty seconds. Direction = W. to E.	....	Accompanied by a noise like that of loaded waggons.	Comptes Rendus, t. xii. p. 440; L'Institut, Nr. 376; Colla, Giorn. Astr. 1842, p. 95; Ann. de l'Observ. de Bruxelles, t. iii.
—— —— 31. Between 3 and 4 A.M.	Caermarthen, and several other towns in Wales.	A smart shock, accompanied by a very visible tremor of the earth.	....	Accompanied by a rumbling noise similar to the sound of distant thunder. It is to be observed that a shock occurred at Comrie in Perthshire at about 2 A.M. on the same morning. Similar shocks are said to have been observed about the preceding month of November in the neighbourhood of Llanstephan.	Jameson's Edinburgh New Philos. Journ. vol. xxxvi. p. 76.
—— —— ...	Comrie in Perthshire ...	Shocks were felt on the 6th, 18th, and 31st.	....	....	Authorities for October 1839.
—— Feb. 3. 7 P.M.	Eglisau in the canton of Zurich.	A vibration felt beneath the feet as if heavy bodies had fallen under ground.	....	From the 1st to the 5th magnetic perturbations at Cracow, and on the 2nd at Naples.	Mérian; Studer.
—— —— —	Zurich	A vibratory shock ...	....	This account is considered doubtful by M. Perrey.	Communication of M. Colla to M. Perrey.
—— —— 9 or 11.	Gowhatty in Upper Assam.	Sharp and stunning, as if a blow had been struck under the jaw.	....	Accompanied by a low rumbling noise. In this month a splendid meteor was seen all through Upper Assam.	Quart. Journ. Geol. Soc. 1845, p. 142, quoting Journ. Asiat. Soc. of Bengal.

1.	2.	3.	4.	5.	6.
1841. Feb. 15. In the morning.	Oporto in Portugal	A shock			Lamont's Annalen, Heft 1. S. 162; Quételet, Annuaire, 1843, p. 293.
—— —— 18. 5 and 11 P.M.	Genoa	Slight shocks at the hours mentioned.		On the same day there fell three showers of red rain.	Comptes Rendus de l'Acad. t. xiii. p. 215.
—— —— Night between 20 and 21.	Various places in the kingdom of Naples.	Very severe shocks			Moniteur, 13 et 28 Mars; Lamont's Annalen, *loc. cit.*; Colla.
—— —— 26. About 7 P.M.	Island of Zante	A most alarming shock of earthquake. The vibration continued from thirty to thirty-five seconds. The shocks afterwards recurred daily.		Preceded by three days and nights of incessant rain with a violent gale of wind. Though of longer duration than the shock of the preceding October, this did much less damage, but a few houses being thrown down, and some others injured.	Edinburgh New Philos. Journ. vol. xxxvi. p. 366; Lamont's Annalen, *loc. cit.*; L'Institut, Nr. 382.
—— —— —	Island of Martinique	Shocks			Colla; Ann. de l'Observ. de Bruxelles, t. iii.
—— —— ...	Comrie in Perthshire	Shocks on the 1st, 14th, and 16th.			Authorities for October 1839.
—— Mar. 6. 1 P.M.	In the island of Ischia, near Naples. The centre of disturbance seems to have been Casa-Micciola.	A severe shock, lasting some seconds, and followed, six minutes after, by a slighter one.		Some damage was done at Casa-Micciola	Colla; Lamont's Annalen, *loc. cit.*
—— —— 9. 11h 30m P.M.	Athens	A vertical shock			Lamont's Annalen, *loc. cit.*
—— —— 17.	Constantinople	Two shocks			Ditto.
—— —— 19. 5h 30m A.M.	Eglisau in the canton of Zurich.	A much stronger shock than that of February 3, and felt over a larger district. Ten minutes later, another slighter shock.			Mérian; Studer.
—— —— 20. In the evening.	Island of Lipari. The west coast of Sicily was also slightly shaken.	A vibratory shock, the most violent remembered by the oldest men of the island.			Moniteur, 18 Avril; Colla.

1841. Mar. 22. $6^h\ 34^m$ A.M.	Coblentz, along the Moselle between that town and Treves, up the Rhine as far as Camp in the Duchy of Nassau, and on the Lahn.	A shock of a second's duration, from N.E. to S.W.	....	Accompanied by very loud noise. The steersman of one of the steamers declared that he saw a blue flame rise from a hill in the distance, which remained suspended in the air for a time, and then sank and disappeared upon the spot it rose from. On the 22nd and 23rd, magnetic perturbations at Parma, Munich, Geneva, Prague, Brussels, Toronto, and St. Helena, and on the 24th at Milan, Naples, St. Petersburg, and Catherinenberg. Meteors were observed at several places.	Moniteur, 28 Mars; Lamont's Annalen, Heft 1. S. 168; Edinburgh New Philos. Journ. vol. xxxvi. p. 367.
—— —— 25.	In Georgia (Caucasus)...	Earthquake shocks on this day and the two next mentioned.	....	....	Quételet, Annuaire, 1843, p. 294.
—— —— 26.	Ditto	....	....	....	Ditto.
—— —— 30.	Ditto	....	....	....	Ditto.
—— —— —	In Calabria	More shocks	....	....	Lamont's Annalen, *loc. cit.*
—— —— ...	Comrie in Perthshire ...	Shocks on March 6, 10, 11, 22, and 23.	....	On the 10th the two inverted pendulums kept at Comrie had their points thrown half an inch to the west. On the 22nd these instruments were also affected, but not to the same extent.	Authorities for October 1839.
—— April 1.	In Georgia (Caucasus)...	Earthquake shocks ...	....	....	Quételet, Annuaire, 1843, p. 294.
—— —— 3. About 1 P.M.	Seiches in the departm. Maine-et-Loire.	A rather severe shock, from E. to W.	....	Accompanied by subterranean noise..............	Moniteur, 13 Avril; Gaz. Piém. 21 Avril.
—— —— — $3^h\ 30^m$ P.M.	In Jutland, and Schleswig Holstein.	Severe shocks	....	Houses were violently shaken, and chimneys were thrown down. The barometer remained in its ordinary condition.	Moniteur, 16 Avril; Colla, Giorn. Astron. 1842, p. 96.
—— —— 13.	Port-au-Prince in St. Domingo.	....	....	....	Colla; Ann. de l'Observ. de Bruxelles, t. iii.
—— —— 19. $5^h\ 30^m$ A.M., 11 A.M., and $2^h\ 30^m$ P.M.	Oban in Argyleshire ...	Shocks, which do not appear to have been felt at Comrie in Perthshire.	....	....	Edinburgh New Phil. Journ. vol. xxxvi. p. 76.
—— —— 21. $1^h\ 35^m$ A.M.	Ditto	Ditto	....	The shock was felt severely at the Lismore lighthouse (103 feet high), which vibrated so as to cause the reflector frame and glasses of the lantern to tingle. The watcher heard a loud noise like that of a cannon discharged at a short distance. This noise was heard at the bottom of the light-house, but the vibration	Ditto.

1.	2.	3.	4.	5.	6.
				was not felt there. The ferry-house at Connal (nine miles east of the light-house) was rent by the shock. No effect was produced on the barometer. A stiff breeze was blowing from the north.	
1841. Apr. 21. $0^h\ 30^m$ P.M.	Athens	A slight shock, followed at $5^h\ 40^m$ by ten others, from E. to W. Later still, another shock of greater force.			Lamont's Annalen. 6 Heft, S. 221.
—— —— 26. O.S. 1 P.M.	Tiflis in Georgia	A slight shock		It was said that the town of Bayazid had suffered much injury.	Memoir of M. Philadelphine on Earthquakes in the Caucasus, quoted by M. Perrey.
—— —— 30. 11 P.M.	In Hungary. Extended from the Sea of Marmora to Altendorf in Gallicia, where a shock seems to have occurred also on the 26th.	A violent shock		Most damage done at Mengard and Tatra. Accompanied by a considerable fall of snow at Altendorf.	Plieninger, Jahrsbericht über die Witterungs-Verhältnisse in Würtemberg.
—— —— ...	Comrie in Perthshire	Shocks were felt on April 3, 9, 12, 14, 17, 24, and 25.			Authorities for Oct. 1839.
—— May 1 to 5.	In the district of Nakhitchewan in the Caucasus.	A slight shock			Moniteur, 8 Déc.
—— —— 5. 9 P.M.	Village of Kewrag in same district.	A violent subterranean commotion, lasting five minutes. At Nakhitchewan it was slight.		Accompanied by a deafening noise at Kewrag. Houses were thrown down. At Nakhitchewan no noise was heard.	Ditto.
—— —— 6.	Ditto	More shocks			Ditto.
—— —— 8. About 3 P.M.	Ditto	Ditto			Ditto.
—— —— 12. 9 P.M.	Monterey in California.	A very short and very slight shock.			Duflot de Mofras, Exploration de l'Orégon, t. ii. p. 56.
—— —— 20. O.S. 3 A.M.	Tiflis in Georgia	A very severe vibratory shock.		Accompanied by two loud subterranean explosions.	Memoir of M. Philadelphine on Earthquakes in the Caucasus, quoted by M. Perrey.

1841. May 23. About noon.	In almost all the communes of the Val-di-Mazzara in Sicily.	A shock of a second's duration, from S. to N.	....	....	Moniteur, 20 Juillet; Journ. des Débats, 12 Juillet; Lamont's Annalen, *loc. cit.*; Colla.
——— —	Some places in the kingdom of Naples.	Shocks	....	....	Ditto.
——— ...	Comrie in Perthshire ...	Shocks were felt on May 5, 8, 22, 26, 27, 28, and 30.	....	....	Authorities for Oct. 1839.
— June 1.	Kingston in Jamaica ...	An earthquake	....	Preceded by heavy rains..................	Edinburgh New Philos. Journ. vol. xxxvi. p. 367.
——— 5. 11h 40m A.M.	Athens....................	Very severe shocks...	....	....	Lamont's Annalen, Heft 6. S. 221.
——— 8.	Several places in the kingdom of Naples.	Strong undulatory shocks from S. to N.	....	....	Journ. des Débats, 12 Juillet; Moniteur, 20 Juillet; Lamont's Annalen, Heft 1. S. 160.
——— 9.	Ditto. Felt at Sulmona.	Ditto	....	....	Ditto.
——— 10.	Ditto. Felt at Lancrano. In Sicily also these shocks were perceived, but there they were of but slight intensity.	....	....	At Tarente houses were thrown down	Ditto.
——— 12.	St. Louis, near the junction of the Missouri and Mississippi.	An earthquake	....	....	Edinburgh New Philos. Journ. vol. xxxvi. p. 368.
——— — 4 P.M.	Island of Terceira. Azores.	An earthquake, which recurred with greater severity at 5h 25m P.M.	....	....	Edinburgh New Philos. Journ. vol. xxxvi. p. 367; Journ. des Débats, 15 et 16 Juillet; Moniteur, 16 Juillet; Lamont's Annalen, Heft 1. S. 162; v. Leonhard's Taschenbuch, 1 Jahrgang, 1846. S. 205.
——— 13.	Ditto	Tremblings felt at short intervals during the day.	....	....	Ditto.
——— 14. 4 A.M.	Ditto	A perfectly perceptible undulation.	....	A number of buildings were destroyed..........	Ditto.
——— 15. 3h 30m A.M.	Ditto. Only some of the severer shocks were felt in the adjacent islands.	A vibrating and distinctly visible rocking motion. The ground then remained comparatively quiet up to	....	The Villa da Praia de Victoria was reduced to a complete ruin. Not a single house or edifice escaped. Several villages in the neighbourhood were destroyed in the same manner. Every convulsion was preceded by a loud subterranean or submarine noise, which exactly	Ditto.

1.	2.	3.	4.	5.	6.
		$2^h 40^m$ A.M. on the 16th, when another violent shock was felt. Others were felt at intervals up to the 24th of the month.		varied in intensity with the force of the shocks. A rent of a mile in length was formed in the ground, extending from the shore. The soundings around the island were not altered.	
1841. June 15.	Paia in Portugal	A vibratory shock ...	....	....	Quételet, Annuaire, 1843, p. 295.
—— —— 16.	Several places in the kingdom of Naples.	Strong undulatory shocks from S. to N. They continued to be felt at Sulmona up to the end of the month.	....	....	Moniteur, 20 Juillet; Journ. des Débats, 12 Juillet; Lamont's Annalen, Heft 1. S. 160.
—— —— 21. 11 P.M.	Büsserach and Rheinwyl, in the canton of Soleure.	Several shocks	....	Accompanied by rolling noise from S.W. to N.E.	Mérian.
—— —— 29. About 10 A.M.	In the departm. Indre...	A shock followed by a second in a few minutes. Both extremely slight.	....	Accompanied by a sharp and prolonged subterranean noise.	Vid. authorities for July 5.
—— —— 30. $11^h 15^m$ and 25^m (A.M. or P.M.?).	Châtillon-sur-Indre, and Buzançais.	Shocks..................	....	Accompanied by loud subterranean noise.........	Ditto.
—— —— ...	Comrie in Perthshire ...	A single shock on the 29th.	....	....	Authorities for October 1839.
—— July 1.	Châtillon-sur-Indre, and Buzançais.	Another shock	....	A strong S.W. wind on the four following days.	Authorities for July 5.
—— —— —	Bayazid in Georgia......	....	....	The town was swallowed up in consequence of an earthquake. The account requires confirmation.	Gazette de France, 21 Août.
—— —— 3. $2^h 7^m$ P.M.	Monterey in California. Felt on the farm in the interior.	Another shock. There were four oscillations, horizontal, from N. to S.	Felt at sea	Preceded by a terrible noise like the increasing roll of thunder, which lasted about twenty seconds. Meteorological and magnetical instruments were not affected. Earthquakes are said to be frequent in California.	Duflot de Mafras, Exploration de l'Orégon, t. ii. p. 56.
—— —— 4. About $9^h 30^m$ P.M.	Kinlochmoidart in Argyleshire.	A slight shock.........	....	Accompanied by rumbling noise..............	Edinburgh New Philos. Journ. vol. xxxvi. p. 76.

1841. July 5. Early in the morning. At Leblanc-sur-Indre, about midnight of the 4th. At Bligny-sur-Ouche, near Arnay-le-Duc, between midnight of the 4th, and 0^h 30^m A.M. of the 5th. At Bourges, 0^h 30^m A.M. At Caumacre, near Rochemore, south of Tours, about midnight. At Langé, canton of Valençay (Indre), 0^h 28^m. At Pont-Levay, 0^h 30^m. At Quinçay, S. of Blois, at 0^h 30^m and about 3^h 30^m. Near Nogent-sur-Vernisson (Loiret), 0^h 45^m. At Chartres, Longjumeau, Grignon	Over a large part of Central France. The principal places where the earthquake was felt are noted in the other columns.	At Leblanc-sur-Indre the shocks were severe enough to shake the furniture of the houses violently. At Bligny-sur-Ouche, three shocks equally strong. At Bourges a kind of heaving motion; there were two shocks, followed by a third, very slight, one at about 3 A.M. At Caumacre, a severe shock from N. to S., lasting two or three seconds. At Langé the most severe shock at 0^h 28^m was followed by a second four or five minutes later, by a third at 3^h 44^m, and a fourth, very slight, at 3^h 45^m; apparent direction =S. to N. At Pont-Levoy, the first shock was from N. to S., and was followed by another at 3^h 30^m. At Quinçay the first shock was severe, apparently from W. to E.; but the second was of less force. At Nogent-sur-Vernisson, a violent	....	Accompanied at Bourges by a loud noise, as if a heavy load had been thrown down in one of the upper stories. At Caumacre the noise was compared to that of a dozen diligences rolling together over the pavement. In the evening it was remarked that the upper clouds were impelled by a south wind and the lower by a north. At Pont-Levoy a deep heavy sound was heard; articles of furniture shook; the wind was very strong, and it rained heavily. At Quinçay the noise was compared to that of carriages on a pavement, or the rolling of distant thunder. Near Nogent-sur-Vernisson the sky was clouded but calm, and the heat suffocating. At Rambouillet the noise was very loud; the sky was calm, but a storm was approaching. In the department de l'Indre a clock which had been stopped in February 1840, and had been left so, was again set in motion by this earthquake, and struck the hours. No effect of any note was produced on the instruments of the observatory at Paris. At Genesse (Seine-et-Oise) and Orleans, where the shocks were felt, the weather was lowering, and the atmosphere seemed charged with electricity. At Marseilles on the 14th and Cette on the 17th extraordinary movements of the sea were observed.	Comptes Rendus de l'Acad. t. xiii. pp. 28, 80, 149, 232; l'Institut, Nrs. 394 et 396; Moniteur, et Journ. des Débats, 8, 9, 10 et 11 Juillet.

1.	2.	3.	4.	5.	6.
(Seine-et-Oise), Orsay, Sèvres, Meulan, and Paris, about 0^h 30^m A.M. At Donnemarie (Seine-et-Marne), 0^h 40^m. At Rambouillet, about 0^h 37^m.		shock from N. to S.; objects were visibly set in motion. At Chartres, and Longjumeau, a severe shock. At Donnemarie, three severe shocks, apparently from S. to N. At Rambouillet, a violent oscillation from W. to E. At Grignon, a rather severe shock from N.E. to S.W. At Orsay seven shocks were counted; the first was the most severe and from S. to N. At Sèvres three shocks from W. to E. At Chevreuse a strong shock from N.E. to S.W. At Meulan, 3 shocks from N. to S. At Paris, also 3 shocks; general direction = N.E. to S.W.			
1841. July 8.	In the kingdom of Naples	Shocks	....	....	Comptes Rendus, t. xiii. p. 449; Quotidienne, 6 Août; Colla.
—— —— 10. Midnight.	Cosenza and Catanzaro in same kingdom.	A severe shock	....	Unproductive of damage	Ditto.
—— —— 13. 1^h 34^m P.M.	Vienna. More severe at Neustadt. Very slight at Gratz.	At Vienna, a slight shock consisting of three quick vibrations from N. to S. At Gratz the direction was also N. to S.	....	At Neustadt buildings were injured	Journ. des Débats et Moniteur, 27 Juillet; Lamont's Annalen, Heft 1. S. 162, Heft 2. S. 178.

1841. July 13. **In the evening.**	**Potenza in the kingdom of Naples.**	A slight shock			Authorities for July 8.
—— —— 15. Between 4 and 5 P.M.	In several parts of the bailiwick of Holbach, in Denmark. Also felt at Copenhagen.	An earthquake		Accompanied by a vibration in the air like that produced by a discharge of artillery. Several walls were thrown down.	Moniteur, Journ. des Débats, Phalange et Quotidienne, 6 Août; Lamont's Annalen, Heft 1. S. 161; Colla, Giorn. Astron. 1842, p. 97.
—— —— 16. $1^h\ 15^m$ P.M.	At Naples and various other places in the kingdom.	Shocks, which at Naples lasted twenty seconds. Direction = N.E. to S.W.		Vesuvius sent forth a little smoke	Authorities for July 8.
—— —— 17. $3^h\ 15^m$ P.M.	St. Jean-de-Maurienne in Savoy.	A slight shock			"Notes additionnelles" to M. Perrey's Memoir on Earthquakes in the Basin of the Rhone, p. 21.
—— —— 18. In the afternoon.	Gundelfingen in the Grand Duchy of Baden, and at Freyburg in the Black Forest.	Three shocks		On the 17th, 18th, and 20th, magnetic perturbations at Cracow; on the 18th at Brussels; on the 19th and 20th at Toronto and St. Helena; and on the 20th at Munich. On the 17th and 18th storms and extraordinary heat in many parts of Europe.	Lamont's Annalen, Heft 1. S. 162.
—— —— 20. 11 P.M.	Guastalla in the Duchy of Parma.	A slight shock, lasting two seconds.			Colla.
—— —— 22. $2^h\ 30^m$ A.M.	Leghorn	Three shocks, one of which was very severe.		The principal shock was accompanied by a loud noise coming from the west. The heat was very great on the 17th and following days.	Moniteur, 2 Août.
—— —— 30.	Lisbon and Leira in Portugal.	Several shocks			Moniteur, 17 et 19 Août; Phalange, 20 Août; Journ. des Débats, 16 et 17 Août; Lamont's Annalen, Heft 1. S. 163; Écho du Monde Sav. No. 661 et 25 Août; Colla, Giorn. Astron. 1842, p. 97; Quételet, Annuaire, 1843, pp. 296, 297.
—— —— —	In Westphalia	An earthquake			Quételet, Annuaire, 1843, p. 294.
—— —— ...	Comrie in Perthshire ...	Shocks were felt on July 2, 23, 25, 26, 30, and 31.		The shocks on the 23rd, 25th, and 26th were rather severe, affecting the instruments to the extent of about half an inch. That on the 30th was still more violent, as, although the motion of the instruments was only about the same (half an inch), the effects on buildings were much greater; chimney-tops were broken, walls rent, &c. Trees vibrated from their very	Authorities for October 1839.

1.	2.	3.	4.	5.	6.
				roots. The direction seems to have been N. to S. There were nine or twelve other shocks felt on the same day, and the principal one extended over a much greater area round Comrie than usual.	
1841. Aug. 2. 10 P.M.	Lisbon and Leira in Portugal.	A slight vibratory shock.			Authorities for July 30.
—— —— 3. $10^{h}\ 18^{m}$ (A.M. or P.M.?).	Ditto	Another shock		No serious mischief is mentioned as having been done, but the inhabitants had taken flight in alarm.	Ditto.
—— —— 4. In the evening.	Seville and Malaga in Spain.	Two severe shocks			Ditto.
—— —— 5. $1^{h}\ 42^{m}$ P.M.	St. Pierre in the island of Martinique.	Strong horizontal oscillations from N.E. to S.W. There were three distinct shocks, of gradually increasing intensity.		The barometer was variable; it fell one line a quarter of an hour after the earthquake, and the weather, which had been excessively hot, suddenly changed to rain.	Phalange, 19 Sept.; Colla, Giorn. Astr.
—— —— —	Several places in Central Spain.	Shocks			Authorities for July 30.
—— —— 6.	Tangiers in Morocco	Ditto			Ditto.
—— —— 7. $10^{h}\ 30^{m}$ P.M.	Seville and several other places in Spain.	Several shocks		Accompanied by noise	Ditto.
—— —— 15. About $3^{h}\ 30^{m}$ A.M.	Messina	A severe shock, followed, two hours later, by two others.			Gaz. Piém. 10 et 15 Sept.
—— —— — $8^{h}\ 9^{m}$ P.M.	Parma	A slight shock; *at once vertical and horizontal, from E. to W.* Lasted about four seconds.			Ditto.
—— —— 16.	Island of Antigua	A shock, described as a sudden and severe jerk, with a short subsequent tremor.			Edinburgh New Philos. Journ. vol. xxxvi. p. 371; Courier de la Côte-d'Or, 14 Oct.; Colla, Notizie Meteorol. 1841, 42, 43, p. 9; Lamont's Annalen, Heft 1. S. 163.
—— —— 17. In the even-	Islands of S^{ta} Lucia, Martinique, and Gua-	In S^{ta} Lucia a shock of appalling vio-		Preceded in S^{ta} Lucia by a hoarse rumbling noise. No serious damage was done, only a	Ditto.

ing in S^ta Lucia.	daloupe.	lence, though lasting but twelve seconds. In Guadaloupe there were two violent shocks, and in Martinique two or three.		few cracks appeared in stone buildings.	
1841. Aug. 18. About 9 A.M.	Castrovillari in the kingdom of Naples, and the environs.	A slight shock, lasting four seconds.	....	....	Gaz. Piém. 10 et 15 Sept.
—— —— 24. 4 A.M.	Sulmona in the same kingdom.	A slight undulatory shock.	....	....	Ditto.
—— —— 25.	Caramanico in the same kingdom.	Rather a severe shock	....	....	Ditto.
—— ——	Comrie in Perthshire ...	Shocks felt on August 1, 10, 12, and 30, all very slight.	....	....	Authorities for October 1839.
—— Sept. 1. Probably O.S. Between 1 and 2 A.M.	Nijne-Tagilsk on the eastern slope of the Oural. Also felt at Tcherno-Estolschinsk.	A shock from W.S.W. to E.N.E. A man who was fishing at the time said that the oscillation came from the N.	....	Preceded by subterranean noise like distant thunder. At dawn the sky was clouded and of a very distinct roseate tint ("avec des étincelles"), which afterwards changed to an orange-yellow colour. This became momentarily so intense that the nearest objects could be discerned, but with difficulty. About 9 A.M. a little rain fell, but the atmosphere retained the same strange appearance up to a late hour of the evening. A similar state of the atmosphere was observed at Perm, Vicimo-Outkinsk, and Tcherno-Estolschinsk; but at the two former places, on the west of the Oural chain, the shock was not felt. A fisherman reported that the fish came up to the surface of the water in a state of great agitation.	Moniteur, 8 Déc.; Bull. de l'Acad. de Bruxelles, t. ix. pt. 1. p. 188; Lamont's Annalen, Heft 1. S. 161; Colla.
—— —— 2. 6 A.M.	Carthago in the province of Costa-Rica, Central America. Also strongly felt in the United States.	An unusually sudden and violent shock. Followed by many more up to the 5th.	....	The shock was so sudden that the persons who escaped from the houses had scarcely time to fly. The whole district about Carthago was covered with ruins. At Turodo, Tres-Rios, Carthago, Parowso, Ujamès, and even in the neighbourhood of Matina (Nicaragua) not a single hut was left standing. The houses not	Journ. des Débats, 16 Janv. 1842; National, 11 Déc. 1841; Lamont's Annalen, Heft 1. S. 163.

1.	2.	3.	4.	5.	6.
				completely thrown down had to be pulled down. From San-José to Heredia and Alajuela the whole country was covered with ruins.	
1841. Sept. 19.	In Styria	An earthquake shock			Communication of Signor Colla to M. Perrey.
—— —— 19 and 20.	Nauplia in Greece	Shocks on the two days mentioned.			Ditto.
—— —— ...	Comrie in Perthshire	Shocks recorded on Sept. 8, 9, 10, 16, 17, 22, 23, and 29.		The shocks during the night of September 9–10 were severe enough to move the instruments half or three-quarters of an inch. The weather for the two preceding days was remarkably wet and close.	Authorities for October 1839.
—— Oct. 5 and 6. In the morning (of the 6th?).	Constantinople	A strong vibratory shock			Colla; Lamont's Annalen, Heft 6. S. 221.
—— —— 6.	Island of S^{ta} Lucia	A slight shock			Quételet, Ann. de l'Observ. de Bruxelles, 1843, p. 298; Lamont's Annalen, Heft 2. S. 193.
—— —— 9. 5h 46m P.M.	Parma	A very slight shock, undulatory, from S.E. to N.W., lasting about 3 secs.			Colla; Lamont's Annalen, Heft 1. S. 184.
—— —— ——	Island of S^{ta} Lucia	A slight shock			Authorities for Oct. 6.
—— —— 13.	Ditto	Ditto			Ditto.
—— —— 14. 8 A.M.	Monte-Leone in Calabria-Ultra, and several other places in the kingdom of Naples.	A slight shock			Journ. des Débats, 20 Déc.; National, 4 Déc.; Lamont's Annalen, Heft 1. S. 163; Colla.
—— —— 15. 2h 30m A.M.	Sanguinetto in the province of Verona.	The first shock, at the hour mentioned, was followed by another ten minutes later, by a third at 2h 45m, a fourth at 3h 30m, and a fifth, the most		Each of the shocks was accompanied by dull explosions, and a kind of hissing noise which seemed to pass rapidly through the air. The night was calm and the sky very clear. Numerous luminous streaks like those left behind by shooting stars were observed. *The explosions seemed to come from the S.W., in which direction flashes of lightning were con-*	Colla.

		severe of all, at 4 A.M. Each was accompanied by undulation.		tinually observed. (Hence probably thunder, and not subterranean noise.)	
1841. Oct. 16. 11 P.M.	Ditto	Another slight shock			Ditto.
—— ——	Wersen near Salzburg in the Tyrol.				Ditto; Communication to M. Perrey.
—— —— 18. 2h 30m P.M.	Torre-di-Passeri in the Abruzzo, kingdom of Naples. Felt also at some other places.	A very severe shock.		No damage done	Authorities for the 14th.
—— —— Night between 20 and 21.	Reggio and Messina in Sicily.	At Reggio, a violent shock. Still stronger at Messina.			Ditto.
—— —— Night between 21 and 22.	In Sicily again	More shocks			Ditto.
—— —— 23 and 24.	Comorn in Hungary	Very violent shocks		All the houses built entirely or in part of wood were thrown down, and the others more or less injured.	Journ. des Débats, 12 Nov.; Quotidienne, 16 Nov.; Phalange, 17 Nov.
—— —— 24. 2h 8m P.M.	Cologne	A violent earthquake, equal to that of thirty years before (13 May, 1812?). Lasted two seconds.		Accompanied by subterranean noise. Houses were violently shaken, walls cracked, and chimneys thrown down. A hot and disagreeable wind had prevailed all the morning. On the same day magnetic perturbations were observed at Cracow, Nertschinsk, Toronto, and St. Helena; and on the next day at Cracow, Parma, Brussels, Milan, Naples, Prague, and St. Helena.	Journ. des Débats, Quotidienne, et Moniteur, 19 Nov.; Phalange, 26 Nov.; Colla, Notizie Meteorol.
—— —— Night between 27 and 28.	Constantinople	A violent shock			Moniteur, 26 Nov.
—— —— 28.	St. Jean-de-Maurienne in Savoy.	A shock		Great oscillations of the barometer were observed at St. Jean-de-Maurienne during the month. During the night of Oct. 24–25 a *doubtful* earthquake at Revermont in the departm. de l'Ain.	"Notes additionnelles" to M. Perrey's Memoir on Earthquakes in the Basin of the Rhone, p. 21.
—— —— 29.	Sanguinetto in the province of Verona.	More shocks		There was also a storm of wind and rain on this day.	Colla.
—— —— 31.	Constantinople	Another shock		Accompanied by a storm	Moniteur, 26 Nov.

1.	2.	3.	4.	5.	6.
1841. Oct. ...	Comrie in Perthshire ...	Shocks on the 5th and 23rd.			Authorities for Oct. 1839.
—— Nov. 18.	Various places in the kingdom of Naples, and at Messina.	Renewed shocks			Bull. de l'Acad. de Bruxelles, t. ix. pt. 1. p. 188.
—— —— Night between 18 and 19.	Biaritz and all along the south-west coast of France, from Boucau to Hindaye in the department Basses-Pyrénées.	An earthquake		Occurred at the height of a terrible storm	Ditto; Moniteur, 30 Nov.; Quotidienne et Phalange, 1 Déc.; Colla.
—— —— 20.	Dôle in the department Jura.	A severe shock			M. Perrey's Memoir on Earthquakes in France, p. 88.
—— —— —	Several places in the kingdom of Naples, and at Messina.	Renewed shocks			Bull. de l'Acad. de Bruxelles, *loc. cit.*
—— —— 21.	Ditto	Ditto			Ditto.
—— —— 27.	Smyrna	A vibratory shock ...			Gaz. Piém. 18 Déc.
—— —— ...	Comrie in Perthshire ...	Shocks were felt on Nov. 3, 5, 6, 7, 8, 18 and 26.		The shock of the 26th was pretty severe, and extended further than usual.	Authorities for Oct. 1839.
—— Dec. 2. At Lons-le-Saulnier, 8^{h} 15 and 30^{m} P.M. At Geneva, a few minutes before 8 (7^{h} 53^{m}). In the neighbourhood of Berne, 8 P.M. At Lyons, 7^{h} 50^{m} (the dates Dec. 3 to 8 A.M. and Dec. 3	Various places in the departments of the Rhone, Ain, Isère, Jura, and Saone-et-Loire; in Savoy, and in Switzerland. Besides those places mentioned in the other columns, the earthquake was felt at Rumilly, Annecy, Arbois, Grenoble, S^{te} Foy-l'Argentière, Bully near Arbresle, la Vavre, Beaujeu, Rossillon, Nantua, Chalons, and Maçon.	At Lons-le-Saulnier rather severe shocks at the hours mentioned. At Geneva three shocks, from S.W. to N.E., in a space of 4 or 5 secs. At Lyons a slight oscillatory shock, lasting some secs. At Vienne (Isère) it was more severe; furniture was thrown down. At Chambéry it was vibratory, and lasted 8 secs. At Belley		Preceded by remarkably hot weather. At Geneva it had rained all day, and the air was charged with electricity. At Lyons a storm accompanied the earthquake. During the motion a compass needle suddenly turned from N. to N.N.W. At Chessy and Anse it blew a storm during the night. At Belley a storm of very hot wind had blown for two days, but ceased during the night and day of the 2nd. At the fort of Pierre-Châtel most of the arms were thrown out of the racks. At St. Rambert-en-Bugey the subterranean noise resembled that of the fall of masses of rock, a frequently observed occurrence in that locality. At Seyssel a magnificent aurora had been observed the day before at 4 A.M. It was seen also at Nantua and Pont-d'Ain. The	Moniteur, 7, 8 et 11 Déc.; Journ. des Débats et Phalange, 7 et 8 Déc.; Quotidienne, 10 Déc.; Bull. de l'Acad. de Bruxelles, t. ix. pt. 1. pp. 14 et 191; Colla; Lamont's Annalen, Heft 1. S. 163; Studer; Communication of M. A. Billiet to M. Perrey; "Notes additionnelles" to M. Perrey's Memoir on Earthquakes in the Basin of the Rhone, p. 21.

to 8 P.M. are given by other authorities for this place). At Chambéry, exactly 7^h 53^m. At Chessy and Anse, 8 P.M. At St. Rambert-en-Bugey, 7^h 47^m P.M.		the direction was N. to S. At St. Rambert-en-Bugey there were three distinct shocks, diminishing in intensity, which lasted together about 10 secs. Apparent direction = E. to W. At Seyssel there were two rather severe shocks, followed in five minutes by another less distinct.		shock was particularly felt in the upper parts of the Alps and in the districts of the hot springs. The springs of this kind at St. Gervais and Courmayeur were troubled the next day. Magnetic perturbations were observed on the following day at Monaco and Prague. Storms of wind and rain prevailed over France.	
1841. Dec. 2 and 3.	Rossano in Calabria	Slight shocks			Colla.
—— 9. At Chambéry, 11 P.M. At Yon and Altemare-en-Bugey, 11^h 20^m. At Aix, Rumilly, Annecy, &c. 11^h 32^m.	In Savoy	A shock which lasted twenty-five seconds with violence, then changed to a slight tremor for thirty or thirty-five seconds (minutes according to Colla), and ended with another shock. Direction of the shocks = S.E. to N.W.		Magnetic perturbations at Naples	Ditto; Quotidienne, 22 Déc.; Communication of M. A. Billiet to M. Perrey.
—— 10.	Belley in the departm. de l'Ain.	Another shock, not quite so severe as that of December 2, but in the same direction.		Shooting stars were observed on this day at Naples, and magnetic perturbations at Nertschinsk.	"Notes additionnelles" to M. Perrey's Memoir on Earthquakes in the Basin of the Rhone, p. 23.
——	Burgschloss on the Neckar, in the grand-duchy of Baden.	A double shock, very severe.			Lamont's Annalen, Heft 1. S. 163.
——	In the Moluccas	An earthquake			M. Perrey's Memoir on Earthquakes in the Basin of the Rhine, p. 97.
—— 14. At Lyons, 2	In Savoy. Also felt at Lyons.	A moderate shock			Communication of M. A. Billiet to M. Perrey; "Notes additionnelles"

1.	2.	3.	4.	5.	6.
A.M. In Savoy, $2^h 30^m$.					to M. Perrey's Memoir on Earthquakes in the Basin of the Rhone, p. 23.
1841. Dec. 19.	Several places in the Grand Duchy of Baden.	An earthquake		Magnetic perturbations observed on this day at Cracow, Munich, Brussels, Parma, Prague, and Milan. On the 18th and 19th a remarkable fall of the barometer at Parma. During the night of 19–20 an aurora borealis at Cracow.	Colla, Giorn. Astron. 1842.
——— 20. 4 P.M.	Kintail in Ross-shire, Scotland.	A severe shock, of which there was no recurrence.		The noise, like the rushing of water or rattling of a carriage, was very distinct. Lightning (with occasional thunder) was extremely prevalent in the west and north highlands this winter.	Edinburgh New Philosophical Journal, vol. xxxvi. p. 84.
——— 21.	In the Moluccas	An earthquake			M. Perrey's Memoir on Earthquakes in the Basin of the Rhine, p. 98.
——— 25. $8^h 54^m$ A.M.	Nikolajewskaja, and neighbouring places, on the eastern shore of the Black Sea.	An earthquake shock, of 3 secs. duration.		Accompanied by subterranean noise. Chimneys were thrown down at Anapa.	Phalange, 1 Avril 1842.
——— 27. $6^h 30^m$ A.M.	In Calabria	A strong shock of earthquake, lasting 15 secs.			Edinburgh New Philosophical Journal, vol. xxxvi. p. 372.
——— 31. 10 A.M.	Pyrgos in the Peloponnesus.	A violent shock, lasting 4½ secs. Several other shocks were felt before the following morning; they seemed to come in the direction of the island of Zante.			Moniteur, 7 Fév. 1842.
——— ...	Comrie in Perthshire	Shocks on the 3rd, 6th, and 7th.			Authorities for October 1839.
——— Month and day not given.	Quebec in Canada	Several persons said they had very distinctly felt a shock of earthquake between 1^h and 2^h,		This account seems very doubtful	Moniteur et Phalange, 18 Juin 1841.

		rock fell from Cape Diamond.			
1842. Jan. 4. 7h 30m P.M.	Seebsagur in Upper Assam.			The weather gloomy and cold	Quart. Journ. Geol. Soc. 1845, p. 143, quoting Journ. Asiat. Soc. of Bengal.
—— 5. 3h 15m A.M.	Castellane in the departm. Var.	Rather a severe shock, followed about ten minutes afterwards by another similar one.			Moniteur, 19 Janv.
—— 10.	Kempten on the Iller, in Southern Bavaria.	A vibratory shock			Communication of M. Studer to M. Perrey.
—— 14. 1h 25m A.M.	Biberach in Würtemberg	A shock, from S.W. to N.E., lasting several seconds, and sufficiently strong to shake windows, furniture, and all the buildings violently.		Accompanied by a noise like thunder. The barometer, between 6 and 7 A.M., stood at 26 in. 2 l. (French !), and the thermometer at −6° R. The motion was more strongly felt in elevated situations than in low ones.	Plieninger, Jahrsbericht über die Witterungs-Verhältnisse in Würtemberg.
—— 15. 1h 20m A.M.	Ditto	Another shock, vertical, and less severe than the last. Followed soon after by two undulatory shocks.		The air calm, and sky clear. Barometer at 26 in. 5·6 l. Thermometer at −6°.	Ditto.
—— 16. 1 P.M.	Ditto	Another shock		This shock, like the first, was more strongly felt in the southern part of the town.	Ditto.
—— 17. Between 3 and 4 (P.M.?)	Ditto	Ditto		Ditto	Ditto.
—— 18. 6h 40m P.M.	Ditto	Ditto. At first vertical, then undulatory from N.E. to S.W.		Preceded by a noise like thunder. Barometer on this day = 26 in. 8 l. Thermometer = 0° R.	Ditto.
—— 19. 0h 50m A.M.	Ditto	Another shock, rather severe.		There was a fall of snow on this day	Ditto.
—— —	Patti in Sicily	Slight shocks, which recurred on the 20th and 22nd.			Colla.

1.	2.	3.	4.	5.	6.
1842. Jan. 23. At Foligno at $5^h 15^m$ A.M.	Teramo. S. Angelo, Vicali, and Torre-di-Passeri, in the Abruzzo-Ulteriore, and Chieti and Lanciano, in the Abruzzo-Citeriore, kingdom of Naples. Also at Pesaro in the States of the Church, and at Foligno.	Slight shocks			Colla; Comptes Rendus de l'Acad. t. xv. p. 568.
—— ——	Comrie in Perthshire	Shocks on the 2nd and 7th.			Authorities for Oct. 1839.
—— Feb. 3.	Pyrgos in the Peloponnesus.	Violent shocks during a part of the day and following night. One of them lasted 4½ seconds.			L'Institut, Nr. 429.
—— —— 5.	At sea, vid. Col. 4.		On board the 'Neptune,' in 0°57' S. lat., and 20°47' W. long. (from Greenwich), a shock was felt, as if the ship had touched upon and were passing over a reef of coral. The motion lasted nearly a minute, and was accompanied by a dull rolling noise. The same shock was felt on board the 'Harrison,' in 0° 30' S. lat., and 21° 55' W. long. On board the 'Anna-Maria' also, in 0° 26' S. lat., and 22° 21' W. long. (from Paris or Green-		United Service Journal, April 1842, p. 577; Nautical Magazine, Aug. 1842; v. Leonhard's Taschenbuch, 1 Jahrgang, 1846, S. 210.

			which ?), a violent shock was felt at 5½ A.M., accompanied by a rolling noise. On going upon deck the captain saw the ship trembling as if she would go to pieces, although the sea was quite calm, and the weather fine. At 5h 50m a slighter shock was felt, at 9h 45m another still slighter, and near noon one more, scarcely perceptible.		
1842. Feb. 16. O.S. 7 A.M.	Tiflis in Georgia	An oscillation in a horizontal direction.	....	....	Memoir of M. Philadelphine on Earthquakes in the Caucasus, quoted by M. Perrey.
—— ——17. At Falmouth, 8 A.M.	Helston, Camborne, Redruth, and the mining districts of Cornwall. Felt at Falmouth and the neighbourhood.	....	....	Accompanied by a noise like thunder	Trans. Roy. Geol. Soc. of Cornwall, vol. v. p. 459; Communication of M. Plieninger to M. Perrey.
—— —— 19. 11h 20m A.M.	Loodianah, Peshawur, &c. in the N.W. of India. Not felt in Scinde. Extended from Jellalabad to Shalkur in Thibet on the north, and to Saharunpore on the south.	Lasted one minute, forty-seven seconds at Peshawur; one minute, thirty seconds at Loodianah, where the direction was N. to S.	....	At Simla the smart shock disturbed all the magnets of the observatory violently, but the action on them was merely mechanical. The most destructive effects were produced in the valley of Jellalabad; the defences of Jellalabad itself, which had been repaired with extreme difficulty and toil by Sir Robert Sale's brigade, were almost distroyed, and the exertions of months were thus nullified.	Asiatic Journal, N. S. vol. xxxviii. pt. 2. p. 20; Report of the British Association for 1845, p. 4; Edinburgh New Philos. Journ. vol. xxxiv. p. 107.
—— March 1.	Several places in the kingdom of Naples.	A shock	....	....	Colla; Bull. de l'Acad. de Bruxelles, t. ix. pt. 2. p. 485.
—— —— 4.	Bex in the Canton du Vaud, Switzerland.	Shocks............	....	....	"Notes Additionnelles" to M. Perrey's Memoir on Earthquakes in the Basin of the Rhone, p. 23.

1.	2.	3.	4.	5.	6.
1842. Mar. 5. 9 P.M.	Delhi, Mussoorie, Simla, and other places in the N.W. of India.	Very quick and violent.	....	The magnets of the observatory at Simla were all (mechanically) set in violent motion.	Asiatic Journal, N. S. vol. xxxviii. pt. 2. p. 17; Report of the British Association for 1845, p. 4.
—— —— 6. About 5^{h} 40^{m} A.M.	Florence	An earthquake shock, consisting of a sudden blow, followed by undulation from E. to W. Lasted 4 seconds, and was soon after followed by two slighter shocks.	....	No perceptible effect on the meteorological instruments.	Colla; Bull. de l'Acad. Roy. de Bruxelles, t. ix. pt. 2. p. 485.
—— —— 8. 2^{h} 7^{m} P.M.	Cracow	A slight tremor	....	The needle of the magnetometer remained perfectly stationary, and yet a suspended weight oscillated to a considerable extent. Clocks were not deranged.	Bull. de l'Acad. Roy. de Bruxelles, t. ix. pt. 1. p. 362, pt. 2. p. 146.
—— —— 20.	Pesaro in the States of the Church.	A tremor	....	....	Quételet, Annuaire, 1841.
—— —— 24.	Cotrona and other places in the Calabrias.	A slight shock........	....	....	Phalange, 4 et 6 Mai; Courier Français, 16 Mai.
—— —— Night between 24 & 25.	Different places in Greece.	Local vibrations	....	....	Comptes Rendus de l'Acad. t. xv. p. 583.
—— —— 30. 1^{h} 30^{m} A.M.	Bex and throughout the southern part of the Canton du Vaud, Switzerland.	A severe shock, lasting four seconds at Bex. At Sion the duration was a little greater. At Bâle several persons felt the shock, which seemed to come from beneath upwards.	....	Accompanied by a loud heavy noise, described at Sion as a subterranean explosion.	Bull. de l'Acad. Roy. de Bruxelles, t. ix. pt. 1. p. 292, pt. 2. p. 147; Mérian; L'Institut, Nr. 434; Colla, Notizie Meteorol. 1842, in Ann. Geograph.
—— —— ...	Comrie in Perthshire ...	A single shock, on the 10th.	....	....	Authorities for Oct. 1839.
—— April 1.	Cotrona and other places in the Calabrias.	Three violent shocks.	....	....	Phalange, 4 et 6 Mai; Courier Français, 16 Mai.
—— —— 2. At night.	Sargans in the canton of St. Gall, Switzerland.	Several shocks.......	....	During a tempest	Mérian.

11h 30m P.M.	of Africa.				bats, 18 Avril; Siècle, 17 Avril; Phalange, 20 Avril.
—— —— 6. and 7.	Calamatta and several other places in Greece.	Commencement of shocks which were strongly felt on the 18th and 25th.	....	....	Authorities for the 18th.
—— —— 7. 3h 35m P.M.	Borgotaro in Tuscany.	A shock	....	....	Bull. de l'Acad. Roy. de Bruxelles, t. ix. pt. 1. p. 513.
—— —— 9. 6h 40m A.M.	Ditto	Ditto	....	....	Ditto.
—— —— Night between 9 and 10.	Algiers	A rather violent shock, followed by two others.	....	Accompanied by subterranean noise	L'Institut, Nr. 443; Journ. des Débats, 18 Avril; Siècle, 17 Avril; Phalange, 20 Avril.
—— —— 11 and 12.	Cotrona in Calabria ...	More shocks	....	....	Phalange, 4 et 6 Mai; Courier Français, 16 Mai.
—— —— 18. 9h 40m A.M.	Patras and Athens in Greece.	At Patras a shock which lasted two minutes and a half. At Athens it was less violent, and lasted but 2¼ mins.	....	....	Comptes Rendus, t. xv. pp. 568 et 725; Bull. de l'Acad. de Bruxelles, t. ix. pt. 2. p. 147; National et Courier Français, 17 Mai; Moniteur et Phalange, 18 Mai.
—— —— —— 6h 17m P.M.	Ditto, and at other places in Greece. These shocks were felt in the chain of Mount Taygetus.	At Patras a shock of less violence than that of the morning; lasted two minutes and three quarters. At Sparta the shocks lasted but 25 or 30 secs.	....	At Patras little damage was done, but at Calamatta and Androussa houses and churches were injured. In the province of Maina some of the inhabitants were crushed beneath the ruins.	Ditto.
—— —— 20.	Pesaro in the States of the Church.	A slight tremor	....	....	Comptes Rendus, t. xv. p. 568.
—— —— 25. 3h 55m A.M.	Patras in Greece	A violent shock, lasting a minute and a half.	....	....	Authorities for the 18th.
—— —— 28. 7h 15m A.M.	St. Aubin, Sauge, and Vaumarcus, in the canton of Neufchâtel.	Two severe shocks, the first of which was the stronger. Apparent direction =S. to N.	The lake of Neufchâtel, which before the shocks was quite calm, was suddenly agitated, and waves of consi-	The first shock was accompanied by subterranean noise like distant thunder. The barometer was observed to fall suddenly and immediately to return to its former level; hence the effect was probably mechanical, arising from the blow itself.	Colla, Catalogue of Earthquakes in 1842, extracted from Ann. Geolog.; Mérian.

1.	2.	3.	4.	5.	6.
			derable height rolled in quick succession upon the shore.		
1842. Apr. 28. Between 1 and 2 P.M.	Grenoble	Rather strong oscillation.		On the 29th magnetic perturbations at Parma	M. Perrey's Catalogue of Earthquakes in the Basin of the Rhine, p. 98.
—— —— ...	Comrie in Perthshire ...	Shocks were felt on the 21st and 22nd.			Authorities for Oct. 1839.
—— May 7. 5 P.M.	Island of St. Domingo, especially at Cape Haytien. Extended to Jamaica, Porto-Rico, and almost all the West Indian isles.	Two principal shocks. The second lasted about 3 minutes, the first not so long. Another account says the shocks lasted 85 seconds. Succeeded by many slighter shocks on the 8th, 9th, and perhaps 10th.	Felt on board ships in the roads.	Preceded by very sultry weather. Many houses were thrown down or injured.	Annual Register, 1842, p. 109; several French journals of June 17 and following days.
—— —— 21.	St. Barthelemy in the island of St. Domingo.	A violent shock			National, 28 et 30 Juin; Phalange, 1 Juillet.
—— June 3. 8 P.M.	Därstetten in the Simmenthal, canton of Berne.	A slight shock			Mérian; Studer.
—— —— 4. 1h 30m A.M.	Ditto	Another and more severe shock.		Accompanied by noise. On the 3rd an igneous meteor was observed at Parma and in the south of France. On the 4th, magnetic perturbations at Brussels, and on the 4th and 5th at Munich and Prague.	Ditto.
—— —— 15.	Eegseth or Egyest in the Söndmör, Norway.	A shock of earthquake			Bull. de l'Acad. de Bruxelles, t. ix. pt. 2. p. 485.
—— —— 21.	In Lancashire	Ditto			Ditto.
—— —— 24. 5h 30m A.M.	Island of St. Domingo...	Very severe shocks			Quotidienne, 11 Août et 2 Sept.; Colla, Notizie Meteorol. p. 17.
—— —— 28.	Islands of Grenada, Antigua, and St. Kitt's.				Ditto.
—— —— ——	Leipzig	Shocks			Plieninger, Jahrsbericht über die Witterungs-Verhältnisse in Wür-

1842. June 28.	Comrie in Perthshire ...	Shocks felt on the 1st, 2nd, and 8th.	....	The horizontal pendulum at Comrie was moved on the 8th to the extent of rather more than half an inch.	Authorities for October 1839.
—— In the first half of the year.	Ponce (in the island of Porto-Rico?), 1500 miles east of Saint-Martainville, Louisiana.	A shock of four minutes' duration.	....	Why the position of this place should be fixed with reference to another 1500 miles distant does not appear, unless the shock were felt at Saint Martainville.	Moniteur, 26 Juin.
—— July 3. $4^h 45^m$ A.M.	St. Jean-de-Maurienne in Savoy.	Three slight shocks...	....	....	"Notes additionnelles" to M. Perrey's Memoir on Earthquakes in the Basin of the Rhone, p. 24.
—— —— 8. 5 A.M.	Campoli in the kingdom of Naples.	A slight undulatory shock.	....	....	Bull. de l'Acad. Roy. de Bruxelles, t. ix. pt. 2. p. 485.
—— —— 10. Between 11 A.M. and noon.	Dunblane in Scotland ..	A shock from S.W. to S.E. (?)	....	Perhaps this earthquake belongs only to the series of Comrie shocks.	Communication of M. Plieninger to M. Perrey.
—— —— 12. $4^h 20^m$ P.M.	Calamatta and Sparta, in Greece.	A slight tremor	....	Preceded by a loud aërial noise..................	Courier Français, 26 Août.
—— —— 13.	In Norway	....	....	....	Quételet, Ann. de l'Observ. de Bruxelles, 1844, p. 309.
—— —— 31. About $7^h 30^m$ P.M.	Gross-Kanischa in Hungary.	An earthquake	....	On the 30th shooting stars were observed at Naples, and a remarkable storm occurred at Lyons.	Bull. de l'Acad. Roy. de Bruxelles, t. ix. pt. 2. p. 485.
—— —— ...	Comrie in Perthshire ...	Shocks were felt on the 1st and 10th.	....	....	Authorities for Oct. 1839.
—— Aug. 3. $2^h 8^m$ A.M.	Island of Martinique ...	A shock lasting about two seconds. They were often felt about this time, especially at night.	....	....	National, 19 Sept.; Echo de la Haute Marne, 22 Sept.; Colla, Notizie Meteorol. p. 18.
—— —— 8.	Island of Guadaloupe, at Pointe-à-Pitre.	Very distinct shocks..	....	....	Colla, *loc. cit.*; Institut, Nr. 458.
—— —— 19. About 8 P.M.	Pittochry, between Dunkeld and Blair, Scotland.	Three shocks	....	The night was warm and sultry with a drizzling rain. At midnight the thermometer stood at the unusual height of 72°.	Report of the British Association for 1843, p. 121.
—— —— 22. According to Prof. Kreil, between 6 and 7 P.M.;	In North Wales. Extended through the whole of Anglesea, especially the south-eastern portion. Said	A shock	....	....	Ditto; Prof. Kreil in Bull. de l'Acad. Roy. de Bruxelles. t. ix. pt. 2. p. 485.

1.	2.	3.	4.	5.	6.
and at Prague, at $8^h 15^m$ P.M.	by Prof. Kreil to have been perceived at Prague by its effect on the self-registering barometer and thermometer, which, he observes, are sensible to the smallest shock.				
1842. Aug. 26. In the evening.	Catanzaro in Calabria ...	A very distinct undulatory shock.			Colla.
——— ...	Comrie in Perthshire ...	A single shock on the 27th.			Authorities for Oct. 1839.
— Sept. 6.	Island of Jamaica	A slight shock........			Colla. Notizie Meteorol. p. 18.
——— 9.	Gross-Kanischa in the county of Szalad, Hungary. Felt within a circle of six or eight leagues in radius.	Four shocks at intervals of fifteen or twenty minutes.		Several houses were injured and all the glass broken.	Phalange, 5 Oct.
——— 12.	Patras and Athens, Greece.	A severe shock			Quotidienne. 3 Oct.
——— ...	Comrie in Perthshire ...	Shocks on the 2nd, 24th, and 25th.		The first shock on the 24th moved the instruments to the extent of about an eighth of an inch horizontally and a sixteenth of an inch vertically.	Authorities for Oct. 1839.
— Oct. 2.	Girgenti in Sicily	A shock			Colla.
——— Night between 6 & 7.	Dinan in the departm. Calvados.	A shock of 2 secs. duration. The apparent direction of the oscillation was E. to W.		Accompanied by a hollow sound, which some persons took for a clap of thunder; but the sky was perfectly free from clouds, and the noise came distinctly from beneath upwards.	National, 10 Oct.
——— 9.	Baroda, north of Bombay, Hindostan.				Asiatic Journal, N. S, vol. xxxix. pt. 2. p. 409.
——— 13. In the evening.	Coblentz and Neuwied, on the Rhine.	At Coblentz, two shocks. At Neuwied the motion lasted six seconds.		Accompanied at Coblentz by a loud noise. At Neuwied "the devil's house and devil's kitchen" experienced shocks. The air was calm, the temperature mild, and the sky covered with clouds. On the 12th an igneous meteor	Moniteur, 20 Oct.; Colla, Ann. Geolog.

				was seen in the departm. Isère, on the [illegible] and 13th great variations in the state of the barometer were observed at Parma, on the 13th magnetic perturbations at Parma, and on the 13th and 14th at Prague, and 14th at Naples and Brussels.	
1842. Oct. 24. $8^h\ 5^m$ A.M. or $8^h\ 11^m$ P.M.	At Algiers	A rather severe shock, from W. to E., lasting some seconds.		Accompanied by a rolling noise like that of thunder among the mountains. Caused much alarm, especially among the Spaniards.	Globe, 3 Nov.; Phalange, 4 Nov.
—— —— 25. $0^h\ 15^m$ P.M.	Tivoli, in the States of the Church.	A slight shock, apparently undulatory, from E. to W.			Phalange, 15 Nov.
—— —— 29. 8 P.M.	Seebsagur in Upper Assam.	Tremulous motion, apparently from S.W. to N.E.			Quart. Journ. Geol. Soc. 1845, p. 143, quoting Journ. Asiat. Soc. of Bengal.
—— Nov. 1. About $7^h\ 15^m$ P.M.	At Algiers	A strong oscillation, followed almost immediately by another of greater violence.			Gaz. de Milan, 20 Nov.; Communication of M. Colla to M. Perrey.
—— —— 8. Between 8 and 9 A.M.	Montreal, La Chine, Trois-Rivières, and other places in Canada.	Terrible shocks	The waters of the St. Lawrence were violently agitated.	Accompanied by explosions like salvos of artillery. Mr. Edmonds (Rep. Brit. Ass. *loc. cit.*) gives the date Nov. 9, and observes that this was the day before the moon's first quarter.	Moniteur, 5 Déc.; Report of the British Association for 1845 (Trans. of the Sect.), p. 20.
—— —— 9. $10^h\ 15^m$ A.M.	Belpasso and all the southern side of Etna.	A very distinct shock.		Some houses were thrown down. The next day a kind of volcanic dust covered the roofs, plants, &c. in Naples, Pozzuoli, Ischia, and all the south-western part of the kingdom.	Gaz. de France, Moniteur, National, et Courier Français, 17 et 18 Déc.; Phalange, 6 Janv.; Majocchi, Annali di Fisica, t. vii. p. 274; Colla.
—— —— 13.	Nantes, France	A shock		Accompanied by two explosions	Moniteur, 17 Nov.; Bull. de l'Acad. Roy. de Bruxelles, t. x. Nr. 2. p. 16.
—— —— 21.	Several localities in the canton of Neufchâtel. Vaumarens and St. Aubin are mentioned.	Slight shocks			Mérian; Studer.
—— —— 25.	Several places in the Abruzzo Ulteriore, kingdom of Naples. And, the same day, some shocks at Catania.	Three severe shocks, the two first being sudden jerks or blows, and the third undulatory. Total duration = 9 secs.		Some days before, a globe of fire had been seen in the Abruzzo, moving from E. to W.	Authorities for the 9th.

1.	2.	3.	4.	5.	6.
1842. Nov. 27.	Nicolosi and other places near.	Shocks		Followed by an eruption of Etna	Authorities for the 9th.
—— —— 29. About 2 A.M.	In the Commune of Pasla, Calabria Citeriore.	A severe shock			Ditto.
—— —— ...	Comrie in Perthshire...	Shocks felt on the 18th and 29th.			Authorities for Oct. 1839.
—— Dec. 4. About 3 A.M.	At Algiers	A severe shock, consisting of repeated undulations to and fro.		Some houses were injured. Many persons were made ill by the undulatory motion.	Gazette de France, et Courier Français, 16 Déc.
—— —— 5. 6 A.M.	Aquila in the kingdom of Naples.	A severe undulatory shock.			Moniteur et National, 7 Janv. 1843.
—— —— 9. 2 P.M.	On the side of Etna, at Nicolosi, &c.	A slight shock		In the midst of loud explosions, during an eruption of the volcano.	Majocchi, Annali di Fisica, t. vii. p. 276.
—— —— 26. $5^h\ 45^m$ P.M.	Potenza in the Basilicata, kingdom of Naples.	A vibratory shock ...		No damage done	Gazette de France, et Courier Français, 18 Janv. 1843.
—— —— 27.	In Dalmatia	Very many shocks felt between this date and Feb. 11, 1843.			Bull. de l'Acad. Roy. de Bruxelles, t. x. pt. 2. p. 15.
—— —— ...	Comrie in Perthshire...	Shocks on the 4th and 17th.		The shocks on the 17th were felt only at Zomperran, half a mile east of Comrie.	Authorities for Oct. 1839.
—— ...	Zetela, near the mountains of Puebla, Mexico.	An earthquake		Accompanied by an eruption of flame, &c. from To-Ecano.	Moniteur, 20 Déc., under news from Mexico of 20 Nov.

The foregoing Catalogue raisonée, thus completed to the end of the year 1842, was originally proposed to have been extended in the same form, to the end of the year 1850. The discussed annual Catalogues published by Professor Perrey, of Dijon, which commence with the year 1843, were found so complete, after the collation of a considerable term of their epoch with other documents, that it appeared a waste of labour to continue the British Association Catalogue, in its tabular form, through the remaining eight years. This Catalogue therefore here closes, but the discussion for the elements of space and time, now to follow, will embrace its whole period and up to the end of 1850; and will be derived as respects the concluding years from the Catalogues of Monsieur Perrey, a complete list of which will be given.

On the Construction and general Use of Efficient Life-Boats.

By Major-General CHESNEY, *R.A., D.C.L., F.R.S. &c.*

COMPARED with ocean steam-navigation, the subject now to be considered may seem to claim but an inferior place. But when I mention, that it embraces the fate of "all who go down to the sea in ships, and who occupy their business in great waters," I am persuaded that it will not only have the deepest interest for all who have favoured the Mechanical Section with their presence, but it will also, as I hope, be the means of moving a very powerful lever in support of the subject I am about to advocate; for I feel assured, that, on the double grounds of scientific construction and the cause of humanity, ship as well as coast life-boats may fully claim the influential support of the British Association; which may thus be the means of inducing Parliament to provide the funds which are requisite to carry out this great national object.

At the meeting of the Association in Hull last year, I endeavoured to show the lamentable deficiency of life-boats, and the necessity of an improved construction, as well as of a more extensive organization of these boats.

A committee was named in consequence, consisting of Mr. George Rennie, Mr. Blundell, the late Mayor of Hull, Mr. Oldham of that place, Mr. Roberts of Manchester, Mr. Thomson of Belfast, with myself as president, to make a report on this subject, which I now beg leave to submit to the earnest consideration of the meeting. I should premise, however, that the present communication can scarcely be called a *Report* upon Life-boats. I have not had the means of making one; for, owing to the unwillingness of the various life-boat and shipwreck societies to accept Mr. Richardson's challenge, and *test* the qualities of their life-boats against his tubular boat, I have had but little opportunity of judging of the practical advantages of *their* boats. My inquiries have however shown how insufficient many of these are. My remarks must thus be confined to bringing before the Association the imperative necessity of establishing such a number of scientifically-constructed life-boats as may be sufficient to keep pace with our greatly-increased commerce. It is manifest, that however zealous the existing Societies may be, neither they nor the Admiralty possess the necessary funds for this purpose; these can only be adequately provided by Parliament. But in order to effect this object judiciously and economically, it appears to me most desirable, that, as a preliminary step, the British Association should recommend the Government to institute such experiments as will enable the public to form a judgement on a subject which is beset with difficulties. This necessity will be sufficiently shown by a brief enumeration of a few of the appalling facts collected by me since our last meeting at Hull; first glancing at the present state of the coasts of Great Britain and Ireland.

For many years a well-organized system of life-boats has existed at the port of Liverpool, at the annual cost of about £2000; and the carefully collated facts contained in the paper in my hand, show that since 1840 the five life-boat stations belonging to the port of Liverpool have saved 1329 lives, and have during the same period assisted 312 vessels, which would probably give about 60,000 tons; and this, at the low estimate of £10 per ton, amounts to no less than a sum of £600,000 rescued from the waves by their means. Presuming that similar advantages would be the result elsewhere, an extended system of life-boats along our coasts, as well as for vessels at sea, would, in point of expense, be in fact a trifling insurance on the cargoes which would be saved in consequence.

The practical and successful efforts made at Liverpool to lessen the calamities of the sea, caused the Duke of Northumberland to offer prizes for the best description of life-boat. This produced many competitors. But although prizes have been awarded, and boats constructed in accordance with what was presumed to be the best model, nothing has been established which efficiently answers the purpose required; and the greater portion of the coasts of Great Britain and Ireland continue without the means of rescuing our intrepid seamen from a watery grave!

On the south coast of England, which is about 350 miles from the Land's End to the North Foreland, there are but fifteen life-boats stationed; the eastern and western coasts, however, are better provided, there being forty-nine for the former, between the Land's End and Berwick-upon-Tweed, a distance of 448 miles; and thirty-three boats for the latter, a distance of 700 miles; while the eastern coast of Scotland has but six life-boats in all, and the western *only two*, the Hebrides and Shetland Islands not having a single life-boat! There are five on the eastern coast of Ireland, but *not one* on its western shores. So that the Liverpool establishments for the preservation of life in this respect exceed by two the whole number in Scotland, and are nearly double those of Ireland.

The recital of only a few of the losses which have occurred since this subject was agitated last year, cannot fail to show that it is high time that more efficient and improved means were adopted to preserve the lives of seafaring men.

During the gale on the 27th of August 1853, many casualties occurred. The Brenda, with a cargo of timber from Quebec, was wrecked just below Beachey Head. Her crew, expecting her to founder, ran her on shore at Newhaven. No ordinary boat could have lived, says the account, in the tremendous surf; but by the rocket apparatus a rope was got out to the ship, and the crew at length enabled to land, *though in a most pitiable condition.*

During the same night, the Australia, for Rio from Grimsby, was driven ashore off Shoreham. The life-boat was launched, made her way through a tremendous surf, and rescued the crew.

A new life-boat was driven on shore off Kimmeridge during this gale; nothing known of her crew; and many coasters were seen to founder, to which no aid could be given for want of efficient life-boats.

About the same date, Aug. 21, the ship Marie, of 1114 tons, from Lima to England, with guano, foundered at sea; fortunately her crew was picked up by the Spanish barque Maria.

Aug. 24. The Jessie Smith was wrecked in the Orange River, and four men drowned for want of a life-boat.

Sept. 25. The schooner John Laverock, from Glasgow, was wrecked off Islay. All her crew supposed to have perished.

Sept. 27. The Isaac Wright, packet-ship, from Liverpool to New York, full of German and Irish emigrants, struck on a rock about forty miles south of Cork, in rough weather and with a thick fog. She began to fill rapidly. Fortunately the Ocnasta, Captain Hadfield, came to her assistance, but was only able to take eight of her cabin-passengers on board; and she therefore sailed for Liverpool, to procure assistance for the Isaac Wright, which was very deep in the water when the Ocnasta left her. On the 2nd of October, the steam-tug Constitution started from Liverpool in quest of the unfortunate ship, but with what result is unknown to the writer.

Sept. 27. The Australian emigrant-ship Charlemont, 1500 tons burthen, from Liverpool with 435 passengers. She struck on Barwen Heads. The gig was launched, and swamped; the jolly-boat was launched, to convey a line on shore, but capsized; the long-boat was launched, and capsized; then the life-boat—it also capsized. A passenger then volunteered to swim on shore with a rope, which he accomplished; and having succeeded in recovering the life-boat, it was slung on the rope, and used as a cradle for landing the passengers.

Sept. 28. The Annie Jane, from Liverpool, was driven on the Barra Island, one of the Hebrides. Her passengers were emigrants for Canada. Out of 450, 348 men, women, and children were drowned. When off Barra, a breaker struck on her quarter-deck, and the poop-deck sunk, crushing 200 emigrants. In ten minutes more she went to pieces. About daybreak the tide ebbed, leaving the fragments of the unfortunate vessel high and dry, when the survivors, 102 in number, walked on shore.

Oct. 18. The Dalhousie, a first-class Indiaman, was lost off Beachey Head in a gale of wind. She foundered in 26 fathoms water, and every soul on board was lost excepting one seaman. Her crew was sixty-one in number, and she had twenty first-class passengers on board. Notwithstanding the gale, many of these doubtless might have been saved, had any of the ships which were near her possessed an efficient life-boat.

We have such an instance of the preservation of life from shipwreck by the Budehaven life-boat, which saved the crew of the sloop Margaret, of Bideford, on the 5th of November.

Nov. 18. The California, emigrant-ship, which left Sligo on the 18th of September, was wrecked 150 miles off Achill. The passengers and crew left the vessel in three boats, two of which arrived at Duoch and Dagert, having sixty persons on board, fifteen of their number having died from exposure and suffering. The third boat was never heard of. The California sprang a leak, and went down immediately. The Anne Eliza, of 100 tons, of N. Berwick, sailed from Newcastle with coals, about the end of September, and has not been heard of since. She is supposed to have gone down in the gale about that time.

The Lady Evelyn, Captain McClellan, from Hong-Kong to San Francisco, with a cargo of merchandise, 230 Chinese emigrants, and other passengers, left Amoy on the 16th of July. On the 19th a gale came on, and she struck on a reef known as Richard's rocks. The long-boat was destroyed by the fall of the mainmast. About thirty persons remained in the rigging, and got ashore on spars, &c. the following day. All the others were lost.

Aug. 24. The Meridian, from Gravesend, was wrecked off the island of Amsterdam, in the Indian Ocean. She had twenty-six cabin passengers and fifty-eight second cabin passengers on board, with a crew of fourteen. The captain and two others were lost, but the rest saved eventually, after enduring great sufferings.

Nov. 29. The packet-ship E. Z., for New York was lost, with her usual crew and fourteen passengers. She was struck by a tremendous sea, which carried away everything on deck, and swept overboard thirteen passengers and nine of the crew. Only five of the whole number were saved.

Dec. The Marshall, a screw-steamer from Hamburg to Hull, was lost at sea with 150 emigrants on board, in addition to her crew of eighteen men and a valuable cargo. The barque Woodhouse came in contact with a steamer off the Humber, which is supposed to have been the Marshall. Her masts were seen by fishing boats near Keln Sea, about five miles from Newsand Float, and her boats were picked up in the North Sea by a fishing smack.

Jan. 6, 1854. A storm, attended with great loss of life, occurred at Tynemouth. The schooner Eliza, of Kirkwall, with eight or nine men on board, was lost. The vessel capsized, and the unfortunate crew clung to the rigging, and were seen from the shore holding up their hands for assistance. Rockets could not reach them, and there was only one small life-boat, manned by five hands, which attempted to reach the vessel. But, before proceeding far, it filled, and with difficulty regained the shore. A second attempt was equally unsuccessful. Indeed it would have been instant death to all in the boat, if they had dared to approach the wreck with such a life-boat.

Dec. The Reindeer also, from Monte Video to England, Captain Jones, on arriving off Guernsey, the weather being stormy, endeavoured to procure a pilot to run into the harbour for shelter. Unfortunately no pilot would venture out, and the Reindeer struck on a sunken rock, and went down. All hands perished.

About the same date, the crew of a vessel in distress, off Marsden, took to their boat, which was capsized, and all, six in number, perished within sight of the people on shore. They were indeed so near, that their gestures were clearly seen. A line-rocket was thrown to them, but the cartridge, from its dampness, was insufficient, and there was no life-boat to give aid! The vessel was afterwards towed into the Tyne.

Jan. 23. The Bona Dea struck on a rock, and lay on her broadside. *Everything* on deck and in the cabins was washed away. The crew managed to cut away the main- and mizen-shrouds, and she righted; but *everything* was gone, and they remained lashed to the stump of the mizen-mast, without food or water, for twelve days and nights. Their sufferings were most fearful. At length they killed one of their number for food, almost all having become insane. Vessels passed more than once within three miles of them, but it was not until the 4th of February that they were taken off by the Cuba, of Sunderland.

Jan. 26, 1854. The Tayleur was lost on Lambay Island, with 652 passengers and crew on board; 370 lives were lost. The details of this awful event are too fresh to need recapitulation; but there is no doubt whatever, that the use of efficient life-boats, either belonging to the ship herself or the shore, would have been the means of diminishing, if not of altogether preventing such a fearful loss of life.

Jan. 26. The Olinda struck on the Harry Furlong rocks. The crew managed to lower the boats and land the passengers, although a heavy sea was running. The life-boat was driving to leeward, and could not fetch the shore.

Feb. 9. The Menai steamer, on approaching Calais during a heavy sea, was driven ashore close to Fort Rouge. Great exertions were made to get the Calais life-boats afloat, to save the passengers and crew; but owing to the violence of the gale and the heavy surf, this was a work of great difficulty. One life-boat was at length launched, and pulled towards the stranded vessel; but, owing to the heavy sea, it was found impossible to land the passengers. They were therefore left in their perilous position until the tide ebbed, when the Menai was left high and dry, and all were landed. But do such *life-boats* as these deserve their name?

A little before this, the Staffordshire, a fine emigrant ship from Liverpool to Boston, of nearly 2000 tons, with 198 passengers, chiefly emigrants, and several ladies, struck on the Bloun rocks, off the Seal Islands, on the north coast of America. Two of her boats broke adrift. The remaining two could only hold a few persons, and these had scarcely got clear of the ship, when she went down with 175 human beings, including the captain; fifty persons, among whom was only one female, succeeded in reaching Seal Island after great sufferings.

March 11. The Grace M'Iva was wrecked on the coast of Brittany, near

Brest. The fate of her crew is unknown; they are supposed to have attempted to escape in their boats, of which none remained with the wreck, and which of course were *not life-boats*.

April 29. A collision occurred in the Channel, off the Start, between a Bremen emigrant ship, the Favorite, for Baltimore, with 200 passengers, and an American vessel, the Hesper, bound to Antwerp. The collision took place between one and two in the morning. It rained, and there was a heavy sea running. The captain and five men sprang on board the Hesper the moment the collision took place; but the heavy sea separated the vessels, and the Favorite went down with 200 emigrants on board!

The City of Glasgow steamer was lost at sea about the same time. No intelligence has been received of her passengers or crew, 480 in number.

April 24. The Italian steamer the Ercolano, in consequence of the carelessness of her captain, was run into by the Sicilia. Almost all on board were lost. Sir Robert Peel escaped with difficulty, but considers that many on board the Ercolano might have been saved if proper means had been taken.

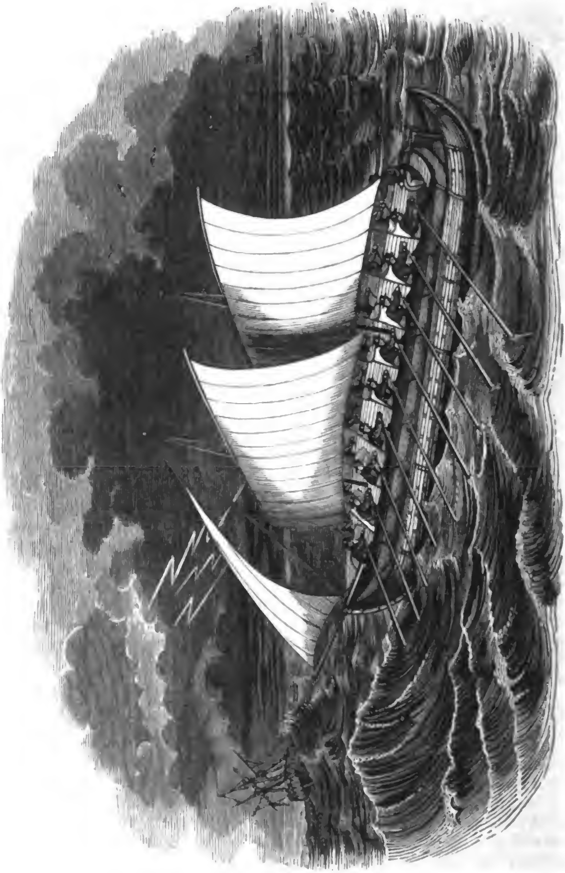
These calamities, however numerous they may seem, are but a small part of those which have occurred during the last four years. According to the casualties compiled from Lloyd's list, and laid before Parliament, there have happened at sea during that period 12,360 disasters, varying in magnitude from a total shipwreck to a slight collision. Of these, 204 ships left our ports, and were never heard of again; 5117 were driven ashore, and, with their cargoes, either totally or partially lost; 2665 were collisions, which drove them into port in a sinking state; 2295 were wrecked; 883 foundered; 679 were abandoned by their crews; 87 burnt by accident; 51 damaged by ice, &c. The casualties of steam-vessels during the same period of four years were,—103 driven ashore, but afterwards floated again; 146 cases of collisions at sea; 17 wrecked; 30 foundered; 15 burnt; 2 abandoned at sea; 1 capsized; 1 never heard of; 7 returned to port in a sinking state.

But it should be observed, that, with the exception of 64 large vessels above 700 tons, these losses fell chiefly on the smaller vessels, from 90 to 500 tons, and which were *economically* sailed! often weak-handed and badly commanded. As an approximative loss, founded on the scale of four men and a boy to every hundred tons, it would seem that the annual loss of life reported at Lloyd's, averages about 1250, the gross amount for the last four years being 4298. The tonnage, supposing the vessels to average 250 tons each, will give 100,000 tons of shipping lost, which, at £10 per ton, would be ten millions sterling lost during four years.

The fewer accidents to steam-vessels during the same period speaks in favour of their safety as compared with sailing vessels.

There cannot be a reasonable doubt, that if the California, the Lady Evelyn, the Tayleur, and many others, had been provided with good life-boats, such as the one now about to be described, which cannot be swamped under any circumstances, even when sent over the ship's side so as to enter the water in a perpendicular instead of a horizontal position, there would have been an immense saving of life. If, therefore, as in the case of the tubular construction, a safer boat has been or can be contrived, and that by means of a better organized system, life may be largely preserved, the means of effecting this humane object deserves, and it is to be hoped will command, the earnest efforts of the British Association.

Hitherto, public bodies, such as the Trinity Board, the National Institution for the Preservation of Life from Shipwreck, the Shipwrecked Fishermen and Mariners' Royal Benevolent Society, have acted, and continue to act



RICHARDSON'S PATENT TUBULAR LIFE-BOAT.

separately in the good cause; but it is not going too far to express the belief, that one centralized system would be more advantageous than the whole of these desultory efforts, and that all the power of the Government is desirable, and even necessary, in order to work out more efficiently a general plan, with (as a necessary part) more ample means for the preservation of life from shipwreck; and since every British seaman contributes something annually (*3d.* a year) from his limited earnings for this very purpose, he has a right to expect that the funds so raised should be turned to the best account.

The momentous question of efficient life-boats can only be safely dealt with after the most patient consideration, founded upon an extensive series of experiments, both as regards the construction of the boats to be adopted and the encouragement to be given to their crews. As regards the latter, it may here be observed, that the salvage is a reward to those who save part of a ship's cargo; but if the chance of the latter be overlooked in order to save life, there is no pecuniary reward for individuals who make the sacrifice.

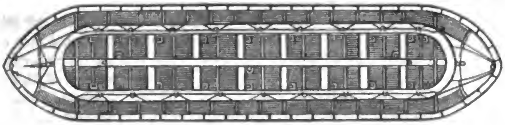
I must now invite the attention of the Association to the peculiar form of the tubular life-boat, which dates from the year 1830, when a wreck at Weymouth, and the previous examination of Blanshard's pontoons, gave rise to the invention, by Mr. Richardson, of this boat, which has already successfully encountered the sea in almost every form.

I need scarcely observe, that Blanshard's pontoons are divided, both longitudinally and transversely, into several compartments by partitions of tin, both to increase their strength and to prevent them from sinking in the water in case of being accidentally perforated in any part. Tubular boats are by no means modern. We have the flying praam of Anson, the outrigger or mosquito boats of the Cingalese and Malays; and others seen by myself in Nubia are built upon this principle; and if water-tight compartments did not belong to Noah's Ark itself, they have been actually in use for ages in the Chinese boats, and also in Europe in various ways.

But although the invention of the tube and water-tight compartments neither is nor could be claimed in this instance, the adaptation of them to the construction of a life-boat, as patented, is due to Mr. Richardson, and is a very important practical step towards the object we are so desirous of obtaining.

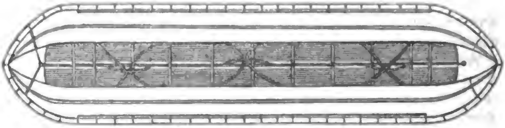
The first boat of this kind was built, as I have before said, in 1830; in 1831 three others were constructed, the largest to row twelve oars; and one so small, that a child in petticoats was in the habit of rowing it alone at Weymouth in the surf in perfect safety. The subject dropped for years, until in 1848 Henry Thomas Richardson, Esq., then an officer in the Fourth Dragoon Guards, and son of the above-named Mr. Richardson, caused a fifth to be built at Manchester.

When the Duke of Northumberland offered his prize, Mr. H. T. Richardson's model was one of those sent in; and although the prize was awarded to Mr. Beeching, so persuaded was he of the superiority of the tubular plan, that he incurred the expense of constructing a boat agreeably to his plan.



DECK VIEW OF RICHARDSON'S TUBULAR LIFE-BOAT.

The boat is formed of two tubes of tinned iron, 40 feet in length by 2½ in diameter, tapering at either end and meeting each other, thus giving the appearance of sheer. An iron frame-work, securely riveted, unites the whole into one mass, the tubes having longitudinal bars of iron and hoops within, and iron keels running from end to end; they are divided into water-tight compartments, occupied by air-proof bags; a cork fender surrounds the whole fabric. The rowers and passengers are placed on a platform above the frame-work, which is surrounded by a light gunwale, the height of the rowlocks. A rope passes along under the kelson for the purpose of towing.



UNDER-KEEL OF RICHARDSON'S TUBULAR LIFE-BOAT.

Sliding keels are proposed to be added, to render her more weatherly. She carries two lug-sails, top-sails and jib; steers, rows, and sails well. This boat was launched on the 15th of January, 1852, but had scarcely been twenty-four hours on the Cheshire shore, when she was found to be wilfully damaged by having had holes driven into the different compartments of her tubes. After repair, she was submitted to the most trying experiments that could be devised. These were, landing her passengers and crew in a gale on a lee-shore, and going off again; towing, in stormy weather, behind a steamer without any one on board, the commander of the steamer having a *carte blanche* to upset, swamp, or tear her to pieces if he could. Having proved in all of them perfectly successful, Mr. H. T. Richardson circulated a challenge to the Shipwreck and other Societies; also to upwards of fifty life-boat stations on the coast of Britain, but *not a boat* came out to meet him.

However, Mr. Beeching having expressed his readiness to meet her at Ramsgate with his prize life-boat, the Tubular set sail, and after a perilous voyage round the Land's End, and encountering very severe weather on her way, reached that place on the 22nd of June, when they found, to their extreme surprise, that Mr. Beeching had disposed of his boat; and the Challenger remained, unopposed, the champion of the field.

On her voyage round from Liverpool to Woolwich, the Tubular was, at Plymouth, subjected to various experiments in the presence of the Port Admiral, Sir John Ommanney, alongside of the Leander frigate, as the following extracts from letters will show.

These letters are from officers then serving in the Leander; their names are not given, as their permission has not yet been asked, though it is believed that they would have no objection:—"I think Challenger the only thing built, at least that I have heard of, deserving the name of life-boat. That she has no capacity to retain water, that she cannot sink or capsize, was fully proved alongside the Leander, when eighty men on one tube, only immersed it deeper, without in any way affecting the safety of the boat or people in her. It is from having so ably fulfilled all the conditions of the challenge, from her capabilities in other respects, that I would willingly take a boat of the same dimensions as one of our cutters or quarter life-boat at sea; and feel convinced many a valuable life would be saved had a ship such a boat belonging to her; she would also be of great service in landing in surfs, beaching troops or field-pieces, and going up shallow rivers." Again writes another officer:—"I witnessed one of the *most severe trials* possibly could have been put to any boat in the world, and she *behaved admirably* when tried alongside of H. M. ship Leander, June 5, 1852."

Hitherto it has been found to be impossible to capsize the tubular boat, because the force of the sea passes off and through the two tubes; but if she were to be upset by any cause, her buoyancy would be greater than before, and she would become a safe and manageable raft even bottom upwards, and a trial will show that she will sail and prove an effective boat even in this position.

Thus it appears that we may hope that a real life-boat has at length been constructed, but the owners of the Challenger will be the first to condemn her if it can be proved that she is unworthy of such consideration; what is sought is competition with other boats, publicly to prove her worth or worthlessness. And I would also observe, that steam life-boats and steam-ships might be constructed on the tubular plan, and these would be admirably calculated for entering shallow ports and for river-navigation.

An objection has been raised, the only one of which I am aware, that a boat of this construction would not be durable; but experience has proved that iron vessels are very lasting; and if it could be otherwise, I might ask what is to become of the monster vessel, of which Mr. Scott Russell has given us so interesting an account? But on this point I may appeal to the knowledge and experience of every practical man, who will tell you, better than I can do, whether iron boats are or are not durable. And were they not so, there are other materials which might be substituted, provided the tubular principle, as already patented, should be established as the best and safest construction hitherto devised.

But the claims of the tubular life-boat do not by any means rest upon speculation or opinion, however sound; for those who are disposed to examine this interesting question at more length, will find ample proofs of her capabilities in rowing, sailing, steering, &c., as detailed in 'The Cruise of the Challenger Life-boat from Liverpool to London,' published by Pickering; where it may also be seen that a chivalrous feeling in the cause of humanity caused the Messrs. Richardson to undergo the privations and hardships of experiments in the depth of winter, and a long voyage subsequently, in order to test the good qualities of their boat by competition against any other that has been built, in the midst of a surf, and under the various circumstances required to establish the efficiency of a life-boat.

It may be added, in conclusion, that Mr. Richardson has expressed his readiness to the National Institution for the Preservation of Life from Shipwreck, to meet any of their boats for the purpose of a trial, at any time and place between the Land's End and John O'Groat's house, or on the west coast of Ireland between Cape Clear and the Causeway*; and thus to prove practically whether the Tubular is or is not the best life-boat at present in use to save life, as it would undoubtedly be the cheapest construction, if the chivalrous object of the inventor should be accomplished.

Up to this time the challenge of Mr. Richardson has not been accepted. But with the same object still at heart, of proving that their boat is admirably adopted to save life and be eminently serviceable in the cause of humanity, as well as showing a great advance in the *science* of life-boats, the Messrs. Richardson have lately built a schooner-yacht to take their life-boat from place to place, with the express object of competing with any other boat, and also of seeking opportunities during the coming winter of testing her capabilities in the great work of saving life, where no other kind of boat can accomplish this object.

---

* To this proposition a letter was received, dated October 7, 1853, ending in these words:—"I am directed respectfully to acquaint you that the Committee do not deem it desirable to comply with the request."

(Signed) Rich. Lewis, Secretary.

I may mention, that these gentlemen fully intended to have been present at the Liverpool meeting of the British Association, and up to Saturday, Sept. 23, I quite expected their arrival in the Mersey with their schooner (the Hirnant) and the Tubular. But they have been detained at Southampton by contrary winds; and Mr. Richardson, Jun., has also met with a serious accident to his hand, which has prevented him from bringing the Tubular by rail, as he would otherwise have done. I regret very much that they are not here to show what she can do.

A very ingenious life-boat has also been built by Mr. Andrew Henderson, which is now to be seen in the dock, the model of which is at present in St. George's Hall. Other boats have also been contrived. One, in particular, of India rubber, by Mr. Parrott, somewhat approaching Mr. Richardson's plan, has attracted much attention. I believe that this boat would be deficient in the stability necessary to do good service on a lee-shore, but this is a matter to be tried. It is most desirable that extensive and well-directed experiments should be made, to ascertain the best kind of life-boats, not only for ships, but also for encountering the dangers of a lee-shore.

The British Association aims especially at the advancement of truth in practical no less than in physical science; in all, in fact, in which we can benefit each other and improve the condition of our fellow-men; and it is with this conviction that I feel the subject of the discovery of the best life-boat to be well worthy of the attention and of the best exertions of our Association.

I hope to see suitable experiments carried on by Government, to ascertain the best description of life-boat; and I trust, indeed I can scarcely doubt, that Liverpool will be ready to do its part. The Marine Surveyor of this port seems to think that it would be but right and proper to build one or more tubular boats, in order fairly to test the qualities of this kind of life-boat in common with those hitherto in use. The next point will be to place the necessary establishments on those parts of the coasts of Great Britain and Ireland which are at present quite unprovided with the means of saving life. I presume that the coast-guard would furnish many of the crews, and that the remainder could be provided without much difficulty, since moderate rewards would be sufficient inducements to our fishermen to undertake this duty.

We must all feel that the preservation of even a single life is a momentous question. I will once more therefore, state my belief, that the Tubular Life-boat of the Messrs. Richardson cannot be either swamped or water-logged; and that she possesses the additional advantage of being a safe row-boat on a lee-shore in the worst weather. She is well adapted for saving life, not only under such circumstances, but also in case of a vessel about to founder at sea and provided with one or more of these boats, to save her crew and passengers on an emergency.

Ample trial of this and other life-boats appears to be the necessary preliminary step to be urged on the Government, as one of the best means of furthering the establishment of life-boats on a scientific principle.

A Third Report (supplementary to two former Reports made to the British Association 1832 *and* 1840) *on the present state of our knowledge of Radiant Heat. By* the Rev. BADEN POWELL, *M.A., F.R.S., F.R.A.S., F.G.S., Savilian Professor of Geometry in the University of Oxford.*

PART I.

HAVING been honoured, for the third time, with a request from the General Committee to continue my former Reports on the state of our knowledge of Radiant Heat, from the date of my last Report, 1840, up to the present time, I feel bound to explain that the resolution conveying that request was passed so long since as the Meeting at York in 1851, and that it was complied with on the understanding that the report was not required immediately. But at the present date, being unwilling longer to delay, and finding that from the pressure of other avocations there is little probability of my being able to complete it, rather than withdraw altogether, I am induced to ask the indulgence of the Association for submitting only *a portion* of such a report.

Preliminary remarks.

Before commencing any analysis of recent investigations, it will be necessary (for reasons which will become apparent) to take in the first instance a very brief *retrospective* glance at certain fundamental distinctions affecting the whole subject, long ago pointed out, but too much overlooked by some writers since. It results from researches pointed out in detail in the two former reports, that under the somewhat wide term "radiant heat" several totally distinct species of effect have been included.

(I.) The simplest form of radiant heat, and most properly so called, is that which arises simply from the cooling of a hot body, and which emanates from terrestrial hot bodies of *all* temperatures, from those which are the least elevated above that of the surrounding medium, up to the highest incandescence or combustion; and is distinguished by two properties:—

(*a.*) A tendency to be absorbed by bodies in proportion to a certain peculiarity of *texture* in their surface, but wholly independent of their colour.

(*b.*) A total incapacity to pass by direct radiation through many media, such as glass, &c., though transmissible freely through rock-salt and partially through certain others, called diathermanous media, as found by the experiments of Melloni.

II. At a certain stage of incandescence *other rays*, also capable of exciting heat, begin to be given off *along with the former*; these are distinguished by the properties, different from the former:—

(*a.*) A tendency to be absorbed by bodies in proportion to the darkness of their *colour* or their absorption of light.

(*β.*) A power of transmissibility through *all transparent* substances, without diminution through colourless media, and in various proportions through coloured media, according to their action on light.

(*γ.*) The power of exciting also the sense of *vision*, or being luminiferous.

This second species *coexists* in various proportions with the first, and is most copious from the most intensely ignited bodies.

III. Closely analogous to this last species, or identical with it, are the heating rays of the *sun*; characterized by the same properties, (*a.*), (*β.*) and (*γ.*); and distinguished by being totally free from all admixture of the first kind (or Species I.)*.

---

* This result was formerly obtained by exposing together a blackened and a white-washed thermometer to the solar rays, first with, and then without, a thick glass screen: in this

When by artificial means the luminiferous rays are *analysed*, some rays are found in which great heating power coexists with feeble illuminating power, but under the *same* conditions and for the *same ray*, the heating is probably directly proportional to the illuminating intensity.

In this way it was that from the distinctions obtained in my original experiments (1825), I was led to describe generally the communication of heat as effected in *three* distinct ways:—

(1.) By conduction (including what some term convection).

(2.) By radiation (in the ordinary sense of the term), or mere cooling of a hot body (Species I. above).

(3.) By the agency of light, whether from the sun or flames (Species II. and III.).

In the first instance, it was natural to regard these as so many distinct kinds of physical action producing heat, but more recent researches, especially those of Professor Forbes, have enabled us to connect them by the simple and uniform analogy supplied by the undulatory hypothesis. If we adopt the hypothesis of undulations of decreasing lengths, those of the greatest length correspond to the Species I., these continue to be given out as the temperature is raised, or as combustion proceeds more intensely, along with others of successively less wave-length, until we arrive at Species II., or those which are of the proper length to affect also the retina with the sense of vision; and at last the wave-lengths are too small to produce either luminiferous or calorific effects; but here they seem to obtain their maximum of chemical action. But rays of *all* wave-lengths thus continue to be given out *simultaneously*. They all produce or excite heat more or less when stopped or absorbed; and this probably dependent, in some direct ratio, on the greater wave-length simply; while the illuminating effect depends on some peculiar relation to certain wave-lengths only determined by some physiological conditions of the retina at present unknown. Substances which are transparent transmit freely rays of the visual wave-lengths, which of course carry with them their heating powers.

Opake substances which are diathermanous transmit in the same way rays of the longer wave-lengths, but not those of shorter.

The action of the *texture* of surfaces seems purely mechanical, and probably influences the absorption of all rays, but its full effect is produced on the rays of longer wave-length; while that of *colour* is purely *optical*, and applies to rays of luminiferous wave-lengths only.

Refraction, polarization, interference, and the like properties of *light*, it would be easily seen, must be accompanied with just such indications of *heating* effect as might consist with the modification which the *light*, in the respective cases, might undergo. If the *light* were extinguished in certain conditions of polarization or of interference, the *heat* would of course disappear with it, and the changes of intensity would be similar; that is, as regards either the solar rays (III.) or those of Species (II.), and consequently in the case of luminous hot bodies, in which Species I. and II. coexist, the effects in question might be expected to occur, but only as applying to that *portion* of the rays which consists of Species II.

Thus, in a multitude of such cases, these effects might be very small or altogether disguised and hidden. And, moreover, if they were real and sensible for Species (II.), it would not follow that they existed for Species (I.); yet the wave analogy would render it highly probable; and experiment has

instance there was only the smallest difference in the absolute values, and *none whatever in the ratio*, of the rise of the two thermometers. In the brightest terrestrial rays there is a marked and often very great difference in *ratio* as well as amount; this constituted the ground of my conclusions as to the heterogeneity of the species of rays in the latter case.

now proved it to be the fact. This constitutes the peculiar value of Prof. Forbes's researches. In the instance of *luminous* bodies, then, all the combined heterogeneous species of rays undergo these modifications; though possibly in different degrees, and liable to modifications from the different nature of the media employed.

Yet many recent researches seem altogether to ignore these distinctions; and the "radiant heat" from different sources is commonly spoken of as if all of one kind, and of which a certain *per-centage* is stopped, or transmitted, in particular cases, by the interposition of certain substances; whereas the body of rays is *heterogeneous*, and certain integrant rays only are totally stopped or totally transmitted in the respective cases, showing not only quantitative but qualitative differences.

In many researches of this kind the "diathermancy" of bodies is spoken of, and experiments made to measure it, as if it applied indifferently to all species of heating rays, and without any reference to the consideration that for certain species of rays bodies are *diathermanous* simply in proportion as they are *diaphanous* to the particular luminous ray in question; while for other species of rays their *diathermaneity* follows some totally different, and as yet unknown law. The confusion of ideas introduced by the adoption of that term, unqualified by any reference to this distinction, and applied to general conclusions respecting "radiant heat," ought to be sufficiently manifest, yet has been but little considered. And in cases where the rays transmitted by a partially diathermanous body are in fact different in kind (agreeably to the above distinction) from those stopped, there is an ambiguity in the mode of expression; in fact it is not merely a *per-centage* of rays, but an analysis of the whole heterogeneous body into more homogeneous or simple elements, *i. e.* rays of different wave-lengths, or combinations of several such rays.

In my former Report (1832, p. 299), it is mentioned that I had then repeated my original experiment (Phil. Trans. 1825) with a pair of thermometers of a peculiar construction made on purpose, in which very small differences were appreciable; but I did not there state any of the results. As attention has now been recalled to my original experiment, both by the repetition of it by Melloni with the thermo-multiplier, and the more recent confirmatory remarks of Knoblauch, and as results obtained in this way (notwithstanding the superior claims of the thermal pile) may still possess some interest, it may not be irrelevant here briefly to state the results of a set of observations which have been lying by me since that period. The instrument was unfortunately broken soon afterwards. These observations were made on the rays of an Argand lamp; the thermometers, fixed on one frame at the distance of about 3 inches apart, were exposed first with, and then without, a screen of plate glass one-eighth of an inch thick. The mode of observation was to note the rise of the thermometer, blackened with China ink, in the time which it occupied the white-washed thermometer to rise 1° Fahr.

Screen.		No screen.		Number of observations.
White.	Black.	White.	Black.	
1°	3°	1°	1°·6	20
Another set gave the *first momentary* rise—				
0·5	2	1	1·5	5

A strong and curious confirmation of the heating power derived from *luminiferous rays simply*, has been furnished in a fact mentioned to me by Dr. Bennett, Professor of Physiology in the University of Edinburgh; viz. that in the exhibition of anatomical subjects by means of the oxy-hydrogen microscope, *the light* concentrated *by a lens*, at a few inches distance from the source, had so energetic an action as to burn up and destroy the specimens placed in the focus.

On the Theoretical Explanation of some former Experiments.

The experiments of Melloni (of which some general abstracts are given in my former Report (1840, p. 4)), certainly seem at first sight to present some anomalous results.

The main question which seems to arise is, whether the effects of heat, as compared with those of illumination, do not follow such widely discrepant laws, as to make it difficult to ascribe them to the same set of waves; and this both with regard to terrestrial and to the solar heat.

To take a single instance: *rock salt* is said to be analogous, for *heat*, to colourless media for *light*; *alum* is described as totally impermeable to "dark heat," and *partially* so to the rays from a lamp, that is, it may be *wholly impermeable* to *those* rays of the lamp which are identical with "dark heat" (species I.) in their relation to absorption, according to the *texture* of surfaces, and *wholly permeable* to those (Species II.) which are associated with *light*, and produce this effect in proportion to the absorption of light by dark *coloured* surfaces; or in the language of the wave-theory, wholly impermeable to rays of longer wave-length, and wholly permeable to *certain* rays of smaller wave-length.

In some of Melloni's experiments, rays from the lamp transmitted in *different proportions* by various screens, and then equalized, were afterwards found to be transmitted by *alum* in *similar proportions*. This he describes by the expression that "they possess the diathermancy peculiar to the substances through which they had passed." Yet the fact surely implies no new property communicated to the rays. It merely shows, that as different specific rays out of the compound beam were transmitted in each case by the first screen, alum, though impervious to the lower heating rays (*i. e.* of lower refrangibility or longer wave-length), is permeable to those higher rays; and in different degrees according to their *nature*; an effect simply dependent on the heterogeneity of the compound beam from the flame. Again, with differently coloured glasses peculiar differences of diathermancy were exhibited with the rays from a lamp, incandescent metal, and the sun; but not more various or anomalous than the absorption of specific rays of light by such media. And besides these considerations, it must be borne in mind that a smooth *blackened* surface is itself *unequally absorptive* for the *different rays*, acting (from its colour) more energetically on those of a refrangibility within the limits of the visible spectrum, and which affect the eye as rays of light; and more feebly on the rays of lower refrangibility, and which act more energetically on bodies with reference to the absorptive *texture* of their surfaces.

As (according to my experiments) the solar heat is wholly of that kind which is freely transmitted through all colourless media along with the light, it does not appear that there would be any particular advantage in operating on the solar spectrum with a rock-salt prism. Melloni, however, with such a prism found, on interposing a thick screen of water, the most heating rays (*i. e.* those towards the red end) intercepted (as they are known to be by water), and this caused the position of the maximum to be *apparently* shifted higher up the spectrum, even to the position of the green rays.

On the other hand, many coloured glasses, he found, absorbed the rays in various proportions, yet they left the point of maximum heat unaltered, *i. e.* though variously absorptive for the higher rays, they were not of a nature to stop the lower or most heating rays.

It appears also to be questioned whether the solar beam does not actually contain some rays of Species I., that is, of wave-lengths greater than any of the prismatic rays, including the ordinarily invisible extreme red. My original experiment on this point above referred to may probably be unworthy of comparison in accuracy with those which may now be made with the thermo-multiplier.

It would therefore be highly desirable if an experiment on the same principle as mine, viz. a black and a white thermoscope exposed together, first with and then without a screen, were repeated on the *solar rays*, with a variety of screens, including especially rock salt; with all the increased accuracy and sensibility now attainable by the use of two *thermo multipliers*, by which the differences or identities of *ratio* in the two cases would be rendered evident in the most satisfactory manner. It would be also highly important to make similar observations on the oxy-hydrogen and the electric light.

The theory of unequal wave-lengths, as the sole explanation of the different species of "radiant heat," whether solar or terrestrial, or in other words, the identity of the rays which produce alike the sensations of light, of heat, or other effects, each in some peculiar relation to the wave-length, certainly applies in a very satisfactory manner to a large portion of the phænomena. There may, indeed, be some minor objections or difficulties; but the only formidable outstanding objection seems to arise from a single result, announced long ago by Melloni, and referred to in my former Report, viz. the fact that a certain kind of green glass transmits the solar *light* in high intensity *while it deprives it of all heating power*. This anomaly is indeed in itself so singular as to require very positive authority to substantiate it; and in M. Melloni's statement there is, as appears to me, a certain degree of vagueness; and it is not supported by any numerical results, or even any detailed account of the mode of operating*.

An alleged isolated fact of so extraordinary a character has long appeared to me to demand a strict re-examination: I had hoped that on presenting this Report, in many other respects so imperfect, I might have been able to announce the result of such a repetition. But, unhappily, a variety of causes have hitherto prevented me from carrying it into effect.

Theoretical Refraction of Heat.

An important point bearing on the theory, was indicated very shortly after the communication of my last Report (1840), in my treatise "On the Undulatory Theory applied to Dispersion" (1841). I have there shown (see pp. 71 and 122) that the formula for the refractive index in terms of the wave-length deduced from Cauchy's theory, furnishes a striking coincidence with Prof. Forbes's determination of the index of refraction for a ray of dark heat in *rock salt*. The formula in question may be expressed thus,—

$$\frac{1}{\mu^2}=\mathrm{P}-\mathrm{Q}\left(\frac{\Delta x}{\lambda}\right)^2+\mathrm{R}\left(\frac{\Delta x}{\lambda}\right)^4-\&c.,$$

where μ is the index, λ the wave-length, Δx the small interval of the molecules, and P, Q, R constants. From the nature of this formula, it is evident that as λ is increased the changes corresponding in the value of μ are very small; and when λ is very great, or $\frac{\Delta x}{\lambda}$ extremely small, the value of μ is susceptible of a limit, which will be

---

* On the Identity of Light and Heat, Taylor's Foreign Memoirs, Part III. p. 388.

$$\mu_0=\frac{1}{\sqrt{P}}.$$

This will represent the physical condition, that as we take rays of successively greater wave-length, they will be crowded together into one position of refraction, which will have a bounding or limiting position, beyond which no ray of however great wave-length can be refracted. This will be different for each medium, but will in general correspond to a refractive index not greatly below the index for the extreme red ray, and which is calculated, in my treatise just referred to, for various media. For rock salt it is a little lower than Prof. Forbes's index for dark heat.

The data will be best seen as collected in the following Table*.

Rock salt.		
Ray.	Values of μ.	
	Obs. Forbes.	Theory, Powell.
Mean light	1·558	
Red	1·540	
λ=·000079	……	1·529
Dark hot metal	1·528	
Limit	……	1·527

M. Knoblauch's *Researches.*

Among the most important of recent researches on the subject of radiant heat, are those of M. Knoblauch, Professor of Natural Philosophy in the University of Marburg, which are not to be surpassed for elaborate extent and accuracy of detail. They are given in Poggendorff's 'Annalen,' Jan. and March 1847, and translated in Taylor's 'Foreign Scientific Memoirs,' Parts XVIII. & XIX. 1848.

The memoir is of great extent, and is divided into six sections.

Section I. is entitled "On the Passage of Radiant Heat through Diathermanous Bodies, with especial regard to the Temperature of the Source of Heat."

The author commences with a summary of the results previously obtained, in which he cites the results of Delaroche and others, without reference to the different interpretation which *must* be put upon them if the experiments and conclusions just referred to be admitted.

He observes, that, from the experiments of Melloni, rock salt appears equally permeable by heating rays of *all kinds*: from those of Forbes, prepared rock salt would seem penetrated by heating rays in a greater degree when the source was at a lower *temperature*. Here I would observe that the *temperature* of the source, as such, manifestly bears no direct proportion to the degree of *luminosity*, it being perfectly well known that the temperature of luminosity is very different for different bodies; and these are also of very different illuminating powers. Now as in all cases there are several different species of heating rays emanating at the same time from the source, some luminiferous, and some not so, it is in no way a matter of surprise, or an exceptional case, that the transmissive power of rock salt, or of any other substance, should bear no proportion to the *mere temperature* of the source.

---

* On this point some notices were submitted to Section A. in 1840 and 1841. See Report, 1840, Sect. Proc. p. 14, and 1841, p. 25.

M. Knoblauch, however, instituted an elaborate set of experiments, to ascertain whether any such relation could be maintained.

The experiments were all conducted by means of the thermo-multiplier, which in this instance was constructed with especial precautions to ensure extreme accuracy and sensibility.

M. Knoblauch's first series of experiments included as sources, alcohol flame, incandescent platinum, hydrogen flame, Argand lamp, of which the *temperatures* were in the order of enumeration, the *first* being the highest. The effect of each on the thermo-multiplier was observed with the intervention of a series of screens, coloured glass, alum, mica, colourless glass, calc-spar, gypsum, &c. The transmitted effects varied of course with the different screens; but in every instance they were *smallest* with the *first* source, and *increased* in the order of enumeration, or in the inverse order of the temperatures. (Table I.)

In this series the real nature of the results is in fact evident from the distinctions above drawn. The effect is simply dependent on the *light*, or heating power of Species II., mixed no doubt to a certain extent in some cases with that of Species I.; which last probably *does* bear a close proportion to the *temperature* of the source, but is in these instances overruled by the effect of Species II. being very feebly, or not at all, transmitted by the screens.

In this series also M. Knoblauch found that the transmission through rock salt was *not* exactly equal for all the sources, contrary to the assertion of Melloni: the difference, however, is very small.

In the second series the sources were a vessel of hot water of different temperatures, from 93° to 212°, the radiating side being in each instance covered successively with lamp-black, glass, wool, and in each instance the thermo-multiplier being placed at a greater distance, in the ratio of the increased temperature, so that the effects of direct radiation were equalized. In each instance then a series of screens (the same as before) were interposed, each screen transmitting a different amount of heat, but the results with each temperature being found equal. (Table II.)

In the third series the sources were hollow cylinders of iron and of copper closely surrounding the flame of a lamp, and heated by it to several temperatures, from 234° F. up to a little below redness: in each instance the same equalization was effected as in the last series, and the same series of screens gave varied effects for each screen, but equal effects for each temperature, as in the last series. (Table III.)

The fourth series included platinum in successive stages of heat: 1st, dark; 2nd, just red; 3rd, yellow; 4th, partly white. In each instance the series of screens was applied. In the 1st, 2nd and 4th stages of heat these gave uniform results, increasing with the heat; but in the 3rd case, certain screens gave results *less* than in case 2, while another and smaller number only gave them *greater*. (Table IV.)

The peculiar, and at first sight apparently anomalous circumstance, that platinum, at a stage intermediate between red and white heat, transmits through certain of the screens employed rather *less* heat than when at the *lower* stage of red heat, may however be explained, if we suppose that the rays given off at this intermediate stage are of such a wave-length as to be subject to a peculiar absorption by these particular screens. He then shows, from the conditions observed, that the effect of secondary radiation was fully guarded against.

Hence the author draws the conclusion, "that the passage of radiant heat through diathermanous bodies is not in immediate connexion with the temperature of the source, as was probable from previous experiments; but is alone dependent upon the structure of the diathermanous substance, which is penetrated by certain rays of heat in a greater degree than by others, whether this occurs at a lower or a higher temperature."

In all this there appears nothing to remark, except perhaps the observation that previous experiments might make a contrary result probable, which does not appear to be the case, since (as already observed) the temperature of luminosity has been long known to be very different for different substances. It were to be wished, that when the author speaks of "certain rays" being transmitted, he had more distinctly indicated the species to which they belong, but which seem to conform to the classification before noticed.

Some further experiments were made on sources of different form and size; cubes and cylinders of hot water of several magnitudes, small and large flames, having successively different screens interposed between them and the thermoscope. The results were very uniform for all the sources, proving that the differences in question produced none in the transmission, as indeed might have been expected. (Table V.)

Section II. is "On the Heating of Bodies by Radiant Heat."

Here, after observing in general, as a well-known fact, that the effect is greatly influenced by the *structure* of the surface, he observes,—

"More recent experiments by B. Powell and Melloni have shown that one and the same body is not uniformly heated by rays of heat emanating from different sources, which exert the same direct action upon a thermoscope coated with lamp-black" (p. 205).

And he details some experiments (Table VI.), showing that with a lamp a greater effect is produced on a surface coated with black paper than one with carmine, but with dark heat, a less:—a result which might indeed have been expected from what was well understood before the date of the researches alluded to, and which it was by no means their object to establish.

A set of experiments (Table VII.) proved that for small thicknesses of coating (within the limit of those employed by Leslie and Melloni), the absorption of heat is proportional to the thickness.

Also, that "the temperature of a body, when the thickness increases, is more raised the less it is diathermanous to the rays transmitted to it."

In Section III., "On the Property of Radiating Heat in Bodies," the author examines various cases in which the state of the surface, as in *cast* and *rolled* lead, smooth and scratched more or less closely, was observed as to its influence on the radiation, when the plates were kept heated by boiling water. (Table VIII.)

Similar experiments with copper (Table IX.) confirmed Melloni's conclusion, that the action is purely mechanical.

In another set of experiments (Table X.), the increase of radiation with increased thickness of coating confirms the conclusion of Rumford and Melloni, that radiation commences from a certain depth below the surface.

The next set of experiments was directed to answer the inquiry, "Does the radiating power of one and the same body vary according as it is heated to a given degree by rays from different sources of heat?" The answer was distinctly in the negative, the sources of heat being a lamp and a hot cylinder, and the body heated and then radiating, being successively paper coated with carmine, and with lamp-black on the absorbing side, and lastly on both sides: also a plate of charcoal, and carmine spread upon wire-gauze (Table XI.): and again, using carmine blackened next the thermoscope, and plain; and black paper coated with lamp-black next the thermoscope, and plain (Table XII.).

The author thus arrives at the conclusion, "under those circumstances in which the same bodies exhibit an unequal absorptive power, their radiating power is one and the same; and those differences which have hitherto been observed when they are not heated to the same extent, are therefore pure functions of the former, and independent of the latter."

The conclusion, if we understand it rightly, would appear capable of being more easily stated, and indeed rendered at once obvious, from the distinctions at first pointed out: whence it is evident, that the rays of Species I. (as before described) from the cylinder, and those of Species II. from the lamp, will necessarily act very unequally according to the texture and colour of the surface.

But when a body has received the radiation, from whatever source, and converted it into heat of temperature, as in these cases, to an equalized degree, it will necessarily radiate it again in an equal degree with the same surface, from whatever *species of rays* it was originally obtained.

Section IV. is headed, "Comparison of the Heat radiated from different bodies within a certain range of Temperature."

The author commences by remarking that "all former observations upon radiation have only related to the *quantities of heat* emitted by different substances at certain temperatures." The object of the present investigation is to ascertain whether there are any *qualitative* differences; or, as the author expresses it, "whether the heat which radiates from certain bodies, at one and the same temperature or within certain limits of temperature, is of a different kind, according as it is emitted by different bodies, or is excited in them in a different way."

This inquiry was pursued by a series of experiments, in which (1) a vessel of water at 212°, and (2) the flame of a lamp, had in *contact* with them various *adiathermanous* substances, such as metal, porcelain, leather, wood, &c., in the heat given out by which the series of screens gave exactly similar series of effects. As also with the heat from a hollow cylinder of copper or iron surrounding a flame. But when the direct radiation of the flame was employed, the series of results were in proportions considerably different. (Tables XIII. to XVI.)

The author indeed remarks at the conclusion, that these last differences are due to the heat *transmitted* by the screens, *i. e.* the heat conveyed by the luminous rays; as indeed would be manifest according to the views at first noticed.

In another series, (1) an adiathermanous body at several temperatures from 88° to 212°, (2) the flame of a lamp, and (3) a metal cylinder round a flame below 234°, were severally tried with the same series of screens; the results in cases (1) and (3) being found exactly similar, in (2) in a very different proportion.

The same sources were next tried with two screens interposed; the first being successively, metal with holes, silk, ivory, &c., and each of these combined with the several screens of the former series. In all cases the results gave *proportional* series. (Tables XVII. to XIX.)

Another series was conducted with—1st, a flame, and 2nd, water at 212°; each in succession with a screen used first plain and then blackened, the screens being black glass, lac, ivory, paper, &c.; the results being always less with the blackened surface, very similar in each case, and all less with the hot water. (Table XX.)

Another set, with a heated mass and with the hand at its natural temperature for sources, gave similar results with various screens. (Table XXI.)

This, the author says, "disproves the opinion of Forbes, that the heat emitted by boiling water and the hand must be considered as different." I am unable to find in what respect Prof. Forbes supposes them different.

At the conclusion of this section the author adverts to two *practical* inferences from what has preceded.

(i.) The fact, that the amount of heat absorbed by a given body is the same, from whatever source it was derived, is important in regard to the determination of *specific heats by the calorimeter*; for if the heat absorbed by the ice were different as it might be derived from *different sources*, no correct measure of specific heat would be obtained. That it is not so, ensures the accuracy of the results so far as *this* source of error is concerned.

(ii.) The second application is, that "these results lead to a new method of ascertaining whether any substance transmits rays of heat or not" (235); that is, of determining whether any given instance of transmission of heat is really due to *diathermancy*, or is merely secondary radiation.

Thus, to determine whether ivory *e.g.* is really diathermanous: the source of heat is a known adiathermanous substance kept heated by a lamp:—the effect is observed; a known diathermanous screen is then interposed and the effect again observed; the ivory is then substituted for the adiathermanous body and the direct effect equalized to the former; the same screen is then interposed, but now a *greater* effect is transmitted. It follows, that part of the original heat is *transmitted directly* by the ivory, along with that *radiated from* it; or *the ivory is diathermanous.*

Section V., on "the Comparison of the amount of Heat diffusely reflected by different bodies," refers to that kind of irregular reflexion, or dispersion (as it has been sometimes called) of the rays from the roughened, or at least unpolished surfaces of bodies, and which is distinguished from regular reflexion, which is governed by the law of equal angles of reflexion and incidence, by occurring equally at all angles. And the object is stated by the author to be the determination "whether heat, on diffuse reflexion, experiences changes in its properties which distinguish it from that which is not reflected" (384).

The heat being incident on a rough surface is of course partly absorbed and radiated again: to guard against error from confounding this with the proper *reflected* heat, various and careful precautions were adopted.

The author then proceeds to detail the observations, which are of voluminous extent, and the results recorded in a long series of tables. (Tables XXII. to XXXII. inclusive.)

In all this first series the source employed was an Argand lamp without its chimney, and in all cases the mode of operating was similar.

The unpolished surface under examination was exposed to the rays of the lamp, at different distances and at different inclinations, and the direct effect noted: the experiment was then repeated with the insertion of a series of variously diathermanous screens.

The substances used as reflectors were extremely varied; such as bodies agreeing in one property and differing in another, or totally homogeneous, or totally heterogeneous.

Thus an immense range of substances of animal, vegetable and mineral origin, opake or transparent, of all colours and textures, were examined, and the agreements or discordances, according to their various properties, were found extremely varied and curious.

By these results, the author observes, "it is placed beyond all doubt, that heat, on diffuse reflexion, is very differently modified by some bodies to a great extent, while by others it is unchanged" (400).

And these results completely confirm the position already advanced, "that the transmission of heat through diathermanous media depends solely upon the nature of these bodies, by virtue of which they transmit some rays more easily than others" (402).

In a second series the same subject is continued with reference to *different sources of heat*, which were, besides the lamp, platinum at a red heat, the flame of alcohol, and a metallic cylinder heated by being placed over the flame of a lamp, as before:

(i.) The reflexions were first made from that series of substances which had displayed the *greatest differences* in the former instance. The results are given in a similar tabular form. (Tables XXXIII. to XXXVIII.)

The author's general conclusion is, "that the modifications which heat experiences on reflexion are very considerable in the case of the heat emanating from an Argand lamp; that with the heat of red-hot platinum they diminish; with the heat of the flame of alcohol they are still less; and in the case of the heat emitted by a heated iron cylinder, of whatever temperature it may be, between 79° and about 234° F., they absolutely vanish" (407).

Or more generally, "the changes undergone by heat on diffuse reflexion are occasioned both by the nature of the sources of heat and the properties of the reflecting body" (408).

(ii.) It remained, as the author expresses it, to determine "whether those surfaces which exert a *similar influence* on the rays of the Argand lamp, *i. e.* which they reflect in such a manner that the heat reflected by the one is transmitted by the diathermanous media used for testing in the same proportion as that reflected by the others, would also reflect the heat from the other sources, so that the rays reflected by them would pass through these substances in the same manner" (409).

The results of these experiments are given in detail. (Tables XXXIX. to XLIV.)

The question then arose with regard to the *explanation* of these phænomena: Are they owing to any change undergone by the rays in permeating the diathermanous substances, or were they "the consequences of a *selective absorption* of the reflecting surfaces for certain rays of heat transmitted to them, as appeared the most probable view from the experiments of Baden Powell and Melloni?" (415)

This question the author proceeds to examine by a detailed comparison of the foregoing results, exhibited in new tabular arrangements of every case. (Tables XLV. to LI.)

Upon a minute discussion of all these results, the author decides in favour of the second alternative; or "that the changes experienced by heat on diffuse reflexion are merely the result of a selective absorption of the reflecting surfaces for certain rays of heat transmitted to them" (423).

The author also adverts to some other inferences from these experiments; as that, "excepting charcoal and the metals, it cannot be said that any body reflects heat better or worse than any other, because this relation varies with each kind of radiation."

Again: certain bodies of the same colour reflect different kinds of heat, and others of different colour the same kind: and this is connected with the fact, that "every luminiferous source of heat emits a large number of invisible rays, which are susceptible of reflexion and affect the thermal pile" (424).

These, and some other remarks on the dissimilarity in the diffuse reflexions of luminiferous and calorific rays, are not perhaps expressed with that clearness which might be wished.

The subject of Section VI. is "on the Sources of Heat;" which is further explained to relate to the differences in the nature of the rays, or in general the *heterogeneity* of the rays, emitted from one and the same source at the same time; and the differences in this respect, of different sources.

From the previous experiments the author concludes in general, that "the variety of the rays of heat emitted is greatest with the Argand lamp, less with red-hot platinum, still less when the flame of alcohol is used, and has entirely disappeared with the cylinder heated to 212° F." (426).

But he now proceeds to test and extend such conclusions in another way, viz. by the differences exhibited by the rays in the different action of diathermanous bodies upon them, according as they have in the first instance passed through certain diathermanous bodies, or proceeded direct from the source. The differences thus exhibited give increasing proofs of heterogeneity.

And one more important point belonging to this inquiry he investigated, by platinum heated to successive stages, (1) below 234°, (2) at a red, (3) at a yellow, and (4) at a white heat; while in each case the heat was reflected diffusely by various surfaces, and in every instance intercepted by the same series of screens. (Tables LII. to LV.)

From these he draws the conclusion, that the differences which the rays evolved at the successive stages exhibit after diffuse reflexion, on transmission through diathermanous media, are in every instance greater at the stage (4) than at (3); these greater than at (2), and these than at (1). Or in general, that the heat emitted by platinum at these successive stages is successively more heterogeneous as we advance from the lower to the higher.

Again, with the same body it is not in the mere proportion of the increase of *temperature*, as such; nor in different bodies does it follow any proportion to the temperature (as before observed).

The author hints generally at the relation between these degrees of heterogeneity and the differences in the nature of the *luminous* rays emitted; but without laying down any very precise or clearly drawn distinctions as to their characteristic properties.

Transmission of Heat through Crystals.

Melloni had raised the question whether in one and the same body, in a crystal for instance, the quantity of radiant heat transmitted was different along the different axes. In experimenting on this subject in connexion with M. Knoblauch, he found that with transparent rock crystal and with calcspar no difference of this kind was detected.

In a memoir (in Poggendorff's Annalen, 1852, No. 2, translated in Taylor's Foreign Memoirs, Nov. 1852 and Feb. 1853), entitled "On the dependence of Radiant Heat in its passage through Crystals on the direction of transmission," M. Knoblauch has pursued the subject commenced by Melloni.

He took in the first instance a cube of *brown quartz*, having two of its sides perpendicular to the axis of the crystal. The rays of the sun were reflected into a room by a heliostat, and the mirror being metallic they remained unpolarized, and after passing through the crystal (which could be turned with its axis in different directions with respect to the rays), were received on a thermo-multiplier. The effect was considerably *less* in the direction *perpendicular* to the axis. The same result was found with *beryl*; but with *tourmaline*, the effect was *greatest* perpendicular to the axis.

The rays were next polarized by a Nicol's prism, before incidence on the crystal. When the plane of polarization *coincided* with the axis, the heat transmitted was the *same* in all directions. But when *perpendicular to the axis, the differences* before observed in the unpolarized rays, were *increased.*

No difference could be detected between the cases when the rays passed *along the axis* of the crystals, and the plane of polarization was respectively horizontal or vertical.

M. Knoblauch now proceeded to try whether the rays which exhibit *quantitative* differences as above, would show *qualitative* differences in the same cases; that is, differences in the power of transmission through diathermanous bodies.

The diathermanous bodies employed for screens were blue, yellow, red and green glasses.

After transmission through a brown rock crystal, the proportion of rays penetrating the different screens differed in the two positions, parallel and perpendicular to the axis, only within errors of observation.

With the rays previously polarized (as before) sensible differences were observed, the plane of polarization being vertical.

The heat was in all cases greatest through the yellow and red glasses, rather less through the blue, and least through the green.

Another set of experiments, in which the plane of polarization was *horizontal*, gave no sensible differences.

Rays traversing the crystal along its axis, also exhibit no differences, as was likewise the case with rays perpendicular to the axis.

With *beryl* similar observations were repeated; with blue glass the difference is very small, for yellow rather greater: the author infers a real difference.

With polarized light and with the plane of polarization vertical, the differences are much greater with both glasses.

With the plane horizontal no difference was found.

Common light, passed through two cubes of beryl according as their axes were parallel or perpendicular to each other, gave great differences with the yellow and blue glasses, and in an opposite ratio in the respective cases.

With *tourmaline* exactly similar results were obtained in the corresponding cases.

With dichroite also the author says, "so far as the examination extended, qualitative differences dependent on the direction of transmission have also been observed."

At the conclusion the author makes some observations in explanation of the phænomena: these may be more briefly and clearly expressed thus:—

The unpolarized rays incident along the axis of the crystals examined or parallel to it, undergo a certain absorption dependent on the nature of the crystal; and this is no further modified, since in this direction there is no double refraction.

But if the ray be incident perpendicular to the axis, it is divided into two, oppositely polarized; and these are differently absorbed.

That which has its plane of polarization parallel to the axis, has the same absorption as along the axis. That which has its plane of polarization perpendicular to the axis is absorbed more or less than the former, in different degrees in different crystals, and for the different component rays.

When the unpolarized rays are incident, then the result is compounded of these separate effects.

When rays previously polarized are employed, the effects are displayed singly.

The author considers that these distinctions fully account for the observed phænomena.

Upon this we may observe,—

The investigation cannot with correctness be called one on the transmission of "radiated heat" in general; it is restricted to that peculiar form or case of radiation which is manifested in the *solar rays*, and proves nothing as to the radiation from hot bodies, or even that conveyed in the rays from artificial lights, unless, as inferred, by analogy. All the differences observed depend simply on the unequal absorption of the rays of light by the crystals and the coloured glasses.

Melloni's *recent Experiments.*

In the 'Comptes Rendus,' No. 10, p. 429, March 6, 1854, Melloni gives some brief remarks in reply to certain objections raised by MM. Provostaye and Desains against the accuracy of experiments with the thermo-multiplier on the passage of heat through screens.

He points out as the sources of discrepancy, the *oblique* passage of the rays through a thick diathermanous screen, which is greater or less according to the distance, and gives different effects of internal reflexion and absorption in different cases.

To show that the errors objected arise solely from this source, he describes a careful repetition of his experiments in which it was guarded against.

The series of experiments included the usual set of sources, viz.

(1.) The flame of an oil-lamp;
(2.) Incandescent platina kept up by vapour of alcohol;
(3.) Plate of copper heated by lamp;
(4.) Vessel of hot water.

Equalizing the effects on the thermo-multiplier by changing the distance and interposing a rock-salt screen, the diminution of effect appeared the same for the first three sources, but greater for the fourth.

But this last result he contends was simply due to the greater proximity of the source, and consequent greater differences of inclination of the rays: and when equalized in this respect, the difference in question disappeared, or might even be reversed.

In the same notice Melloni refers briefly to other results which have been obtained by means of rock salt.

(1.) That with a prism of rock salt the maximum of calorific effect in the solar spectrum is thrown further from the limit than with other "prismes thermochroiques."

(2.) That the radiation from the sun diminishes from the centre to the circumference; that the radiation from the spots is less than from the rest of the surface, and that of the equatorial region of the sun greater: these results were obtained by M. Secchi.

It may be right to add, that I have been informed that in a work entitled "Thermo-chrose," not long since published at Naples, M. Melloni has somewhat modified his former opinions, and seems disposed to assent to the doctrine of the identity of the rays which produce light and heat, or heat alone, according to their greater wave-length; and has explained and reconciled some of his former difficulties. I regret to be unable at present to give a more precise account.

Mr. Draper, also, I am informed, has been led to admit that the chemical effects belong properly to the same set of rays, differing only in the characteristic of peculiar wave-lengths.

On the whole, the question of the evidence for and against this theory is one eminently deserving of being fully discussed. I can only pretend in this imperfect report to have suggested some of the materials which may assist in forming some judgement on this point.

Analogies of Transmission of Light and Heat by Waves.

The very important researches of Mr. Joule on heat and the dynamical theory to which they lead, though referring directly to heat in its action on bodies as *temperature* or as *latent heat*, yet are not without a bearing on the subject of *radiant heat*, as has been in some degree pointed out in the excellent Address of our President of last year. (Report, 1853, p. xlvii.)

Mr. Joule's theory, though not as such dependent on the wave-theory of heat, is yet eminently in accordance with it, and so far lends it much support. If we suppose the temperature of a body to arise from vibrations of its molecules, such vibrations may be excited in it by the vibrations of an ætherial medium surrounding and penetrating that mass of matter. In this respect the close analogy with sound is preserved. These vibrations of heat, however, produce mechanical changes in the constitution of the medium, they cause it to expand, *i. e.* they drive its molecules to greater distances apart; and when carried to a certain extent, cause a fresh and sudden separation to a far greater extent; accompanied with a new arrangement of these molecules, or a change of *state* in the body from solid to fluid or from fluid to aëriform. Here the analogy with sound ceases to hold good, except so far as that a temporary new arrangement of the molecules is occasioned by the sonorous vibrations. The transmission of luminiferous waves has a velocity, which, though enormous, is capable of measurement. Whether that of the longer non-luminiferous but caloriferous waves is the same, has not been, I believe, experimentally verified, but must theoretically be supposed the same; unless indeed it be only *approximately* the same for waves within the narrow limits of the luminiferous scale, and diverge from that value beyond those limits.

Again, the passage or process of the vibrations in a body receiving heat *is slow*: to this *conduction* of heat there does not seem to be anything strictly analogous in *sound*. In general, the passage of light through transparent bodies excites in them no vibrations capable of affecting our eyes with the sense of light, *i. e.* the medium does not become luminous, unless we except the case of the phosphorescence of fluor-spar and some other bodies after exposure to light. So far indeed as the transparency is *imperfect*, and in all *opake* bodies, the vibrations which constitute light are stopped, or changed in such a manner that they give rise to vibrations in the body constituting *heat*, just as those longer vibrations do which constitute that species of radiation which is derived from the mere cooling of a hot body; but this does not occur in *transparent* bodies. It would seem to be the law, that if a ray, or a series of waves of the proper length to be luminiferous, impinge on an opake body, they communicate vibrations to its molecules, which again transmit to the surrounding æther other waves of *greater length*, which in like manner traverse space and can again excite vibrations in bodies on which they impinge; or if from any source a body have internal *vibrations of a certain intensity* (whether forming *waves*, or of what lengths, we have no means of deciding), it can transmit to the surrounding æther vibrations which constitute waves of lengths *greater* than a certain given length, viz. that which belongs to the deepest red luminiferous rays. If its internal vibrations are increased in intensity beyond a certain point, it then acquires the power of communicating (*in addition* to the last) other vibrations to the æther forming waves of other and smaller lengths, so as to give rise to *light*.

Origin of the Solar Heat. Professor W. Thomson's *Theory.*

Some very important speculations have been brought forward on the *source*, and thus bear on the *nature*, of the solar heat, by Professor Thomson[*] in immediate connexion with the theory of Mr. Joule, and on the principle that the energy of the heat thus emitted must be accompanied by an equivalent expenditure of mechanical force. On this principle he institutes numerical calculations; the main results of which, together with a brief exposition of the principles, may be given as follows:—

The kind of force acting, or the source of solar heat, the author conceives may be expressed by several hypotheses, each of which he examines:—

I. The supposition of the sun being simply a body intensely heated and losing its heat by radiation or simple cooling.

This he considers quite untenable, as well on theoretical grounds advanced in some other papers, as on the simple consideration that if this were true the sun would be extinguished in a very short time.

II. The hypothesis of chemical action or combustion of any kind.

Supposing one of the combining bodies to be supplied from any atmosphere, the products of combustion would be so enormous as to choke the fire, if gaseous, by preventing the access of the air in question, or, if solid or liquid, by preventing the supply of fuel; and according to the mechanical theory before mentioned, a numerical calculation shows that the whole mass of the sun could scarcely last 8000 years, without being all consumed, if generating, by its own burning, the heat which is actually emitted. Hence if the sun is a fire, the fuel must be supplied from external space. But a mass of coal or iron or potassium could not reach the sun from external space without generating thousands of times as much heat from its motion, as it could possibly do by its combustion. Combustion is probably, therefore, insignificant, if it exists at all, as a source of solar heat.

III. The hypothesis of meteors falling into the sun and expending force *mechanically*, has been started by Mr. Waterston[†], who supposes such bodies to be attracted and fall directly into the sun from remote *extra-planetary* regions.

The supply of meteoric matter necessary according to this theory, is estimated to amount to such a mass as would cover the sun's surface to a depth of 30 feet in one year.

The author, however, considers it probable that meteors actually fall into the sun, not directly from distant spaces, but by the action of a resisting medium surrounding the sun, which *contracts* the orbits in which they are revolving round him. He conceives that these meteors must be moving *within* the limits of the earth's orbit, or we should be continually struck by them; and that they are probably the matter of the zodiacal light.

It is however quite conceivable that that cloud of small planetary masses may once have extended beyond the limits of the earth's orbit, and thus in remote periods the earth may have been exposed to such falls of them as to have materially raised its temperature; and hence a possible source of those high temperatures which once existed.

But to return to the effects of the resisting medium: owing to its retardation, the approach of these bodies to the sun is gradual, and on this hypothesis a calculation similar to the former would give the result that the sun must be covered to a depth of 60 feet in a year, or a mile in about eighty-eight years; which would occasion an increase of 1″ apparent diameter in 40,000 years; a change of course utterly inappreciable to observation.

---

[*] Transactions of the Royal Society of Edinburgh, vol. xxi. part 1. On the Mechanical Energies of the Solar System.

[†] British Association, Hull Meeting, 1853.

The amount of matter thus abstracted by the sun would be equal to the mass of the earth in about forty-seven years; but it is quite conceivable that a quantity of 100 times this amount would not be missed from the zodiacal light. Thus the sun's heat might be kept up for 5000 years to come at least. This transfer of matter to the sun coming from a source within the earth's orbits, would not affect the conditions of the system, as to the effects of gravitation.

Some meteors may possibly come direct on the sun from the extra-planetary spaces, but the quantity of such is probably very small in comparison with those that have been revolving in approximately circular or elliptic orbits before falling in.

If we imagine a dark body moving through space and coming into a locality abounding with meteors, their impact may raise it to incandescence, which will cease when it moves out of that space. Thus the author suggests a possible explanation of variable stars.

(Addition I.) The author gives a calculation of the quantity of matter necessary to be added to the sun, on the *extra-planetary* hypothesis, and finds it gives too great an increase of central force to consist with the historical conditions of the earth's motion. He concludes the supply must have been from *within* the earth's orbit for thousands of years at least.

(Addition II.) He shows that the resistance must be very small even close to the sun, since such light bodies as comets pass through it at perihelion.

The solar atmosphere may be conceived to be carried round in a vortex by these revolving masses, but not more rapidly than a planet would be at the same distance. Hence the meteors must long continue to revolve before reaching the sun, *and must get so near as to be completely evaporated before they fall in.*

Hence the solar heat is produced, not by solids *impinging on the sun, but by the violent friction of the rotating vortex of evaporated meteoric matter.*

(Addition III.) The temperature of the different parts of the sun's surface may undergo great changes from the eddies and streams occurring in this revolving mass. Hence many of the appearances of the solar spots and streaks, &c.

(Addition IV.) "On the age of the sun." At the rate of meteoric incorporation above calculated, the present rotation of the sun would be produced from rest in 32,000 years. We may infer (since it appears very improbable that the sun has had a contrary rotation destroyed by meteoric incorporation) that the kind of agency now going on, cannot have been going on and alone generating heat at the present rate, for more than that period. For the future, we know that the mass of the zodiacal light is small, in comparison with that of the sun, from its producing no sensible perturbation on the planets, and we may be sure it cannot keep up the supply for 300,000 years. The sun's rotation has been by no means accurately determined; it may possibly vary to an amount which future observations may detect, and thus test the theory.

Density of Æther.

Another speculation * closely connected with the former and the general subject of radiation, has been pursued by the same author, on the probable density which can be assigned to the *luminiferous* and *caloriferous* æther.

---

* Professor W. Thomson 'On the Possible Density of the Luminiferous Medium,' &c., Transactions of the Royal Society of Edinburgh, vol. xxi. part 1.

This speculation is founded, like the former, on the data furnished by Pouillet's researches on the solar radiation, and Joule's theory of the mechanical energy equivalent to the effect of heat produced: the calculation turns on the assumption that the velocity of *vibration* can only be a small fraction (probably not one-fiftieth) of the velocity of the *propagation of waves*, and from the *velocity of vibration* we may calculate the *density*, or conversely.

Hence the author conceives that we may assign a *limit*, and that *a cubic foot of luminiferous æther, at the distance of the earth from the sun, cannot contain less than* $\left(\frac{1}{1560 \times 10^{17}}\right)$ *of one pound of matter.*

With regard to the results of Prof. Thomson, especially when the novel character of some of the reasonings is taken into account, some difference of opinion may reasonably be expected. There are certainly many considerations involved which might suggest important topics of discussion; on these it is not my purpose to enter: I will merely remark, that in all these investigations the essential point is *the expenditure of mechanical energy in producing vibrations*, of whatever kind. The whole question then assumes a more *strictly mechanical aspect*:—the sure indication that this entire branch of science is in a state of approximation at least towards that stage which characterizes the perfection of any branch of physical knowledge, when all its varied phænomena shall be shown to be susceptible of analysis up to simple combinations of the elementary laws of force and motion.

I would merely add, that in speaking of the effect of the evolution *of heat*, there is nothing in Professor Thomson's conclusion which restricts them to any *one species* of heat; the essential point is the production of *vibrations*: and his results are thus in entire accordance with the theory which refers all kinds of heating effect to the stoppage or absorption of rays, in other words, the extinction or destruction of the vibratory motions, constituting rays of different wave-lengths, some of which are also within those limits, and belong to that part of the scale, which renders them capable of affecting our eyes with the sensation of vision;—which (as already remarked) considerations on all hands seem now tending to show is the most probable hypothesis on the subject.

Radiation of Heat from the Zodiacal Light and from the Comet of 1843.

Some interesting observations on these points are given by M. Matthiessen in the 'Comptes Rendus,' April 1843 (vol. xvi. p. 687).

On the 27th of March, M. Matthiessen placed at the focus of a *concave mirror* of 1 metre diameter, an *air-thermometer*, which showed a similar rise above its indication in other positions, when the axis of the mirror was directed to the *zodiacal light*.

He next substituted for the thermometer, a thermo-electric pile with great precautions; which having its condensing cone

Directed to the nucleus of the comet, gave a deviation of	2°
„ the zodiacal light near its summit	10°
„ the zodiacal light at base	12°
„ the part of sky over the sun	3°
In other directions	0°

On removing the condensing cone to try whether the effect was due to atmospheric causes, he still found towards the base of the zodiacal light 2° or 3°.

Instead of the mirror he next used a *flint-glass lens*, 56 centim. diameter, 16 centim. focal length.

With the thermo-electric pile as before, this gave,

Directed to zodiacal light, summit	2°
„ zodiacal light, base	4°
„ sky over sun	0°

With a *tallow candle* at 10 metres distance (whether with the lens is not stated, but probably with it, as the experiments would not otherwise be comparable),—

With the condensing cone, deviation . . . . 15°.

This, he observes, shows "combien est minime la quantité de chaleur envoyée par la lumière zodiacale, et que l'influence de la comète doit être réellement imperceptible par notre température."

It was perhaps this somewhat ambiguous sentence which led Humboldt to represent these experiments as showing no sensible effect due to the zodiacal light ('Cosmos,' Note 98, p. 394, vol. i. Sabine's translation).

In the face of the experiments, however, we must adopt another interpretation; and perhaps what the author means is the distinction between the *radiant* heat affecting the *thermoscope*, and the *temperature* communicated to the *atmosphere*; which are manifestly different things.

The experiment with the candle, if made (as seems to be implied) with the *lens*, is an important verification of the fact of the *heating power belonging to light* from terrestrial sources.

The result with the zodiacal light also shows that at least a portion of its effect *is of this species*; and not dependent on its mere loss of heat as a *hot* body cooling.

It is, however, but right to add, that indications of such extreme delicacy as those here referred to, have been looked upon by some physicists as almost too liable to uncertainty to be entirely trustworthy.

On some of the results obtained at the British Colonial Magnetic Observatories. By Colonel EDWARD SABINE, *R.A., V.P.R.S., General Secretary.*

AT the meeting which took place at Newcastle in 1838, the British Association, in fulfilment of the first amongst the objects for which it was originally instituted,—that of giving a stronger impulse and a more systematic direction to scientific inquiry,—recommended to Her Majesty's Government the prosecution at the public expense of researches which were required for the advancement of the science of terrestrial magnetism, but were beyond the means of individuals to carry out. These researches were of two kinds, having different, but in many respects connected objects. By one class of observations, for which the aid of naval expeditions to unfrequented parts of the ocean was required, it was desired to determine the distribution in different parts of the globe of the magnetic force of the earth in its two manifestations of direction and intensity of action. By the other class of observations, to be made at stationary observatories placed at points of the earth's surface very distant from each other and judiciously selected, it was proposed to ascertain the particularities of the change which is found to take place from year to year in all parts of the globe in the direction and intensity of the magnetic force, by which change the magnetic state of the earth corresponding to any one epoch passes, as it were, insensibly, but with a regularity and systematic order which manifest the existence of natural causes as yet unknown to us, into successive forms of distribution, which, after the lapse of considerable intervals of time, are found to differ very widely from each other. This change has received the name of secular change. By this second class of observations it was also proposed to trace the laws, and, if possible, the causes, of certain small periodical and other variations, superimposed upon the mean magnetic state of the globe, which, at the time when the observatories were undertaken, were generally believed to be in some way or other connected with the variations in the temperature of the earth or of the air.

For such observatories, our colonial possessions, dispersed as they are in almost all parts of the globe, and presenting almost every variety of climate suitable for a thorough examination of the supposed connexion between the magnetical and meteorological elements, afforded excellent positions; and it was believed that amongst our naval and military officers employed for the protection of the colonies, many might be found possessing the necessary acquirements and disposition to conduct the observations upon a prescribed plan, which should be prepared by a Committee of the Royal Society and sanctioned by the authority of the President and Council of that body.

The recommendation thus made to Government by the British Association, and strengthened by a similar recommendation from the Royal Society, having been acceded to, measures were at once taken for carrying out both classes of observation; and an appeal was at the same time made, through the proper authorities, to the governments of the principal nations of Europe and America, to participate in the inquiries by causing magnetic surveys to be made in their respective countries, and by establishing fixed observatories to carry out for a period of limited duration the same system of observation as that adopted in the British Colonies.

In both departments of inquiry the instruments and methods required for the research were for the most part novel. It was to be expected, therefore, that the experience of the first two or three years would be expended in revealing deficiencies and in suggesting modifications and improvements; and that it would not be until these were devised and brought into use that the system of observation could fairly be considered to commence. A revised edition of the instructions of the Royal Society was published in this view in 1842, and at the meeting of the British Association at Cambridge in 1845, (which was attended by special invitation by many of the directors of the continental observatories which had adopted the British system,) a further application was made to the British Government, and through it to the governments of other countries, to prolong the period for which the continuance of the observatories was originally sanctioned.

The prominent part taken by the British Association in these recommendations naturally produced in its members a strong desire to be informed of the results which had been obtained by their means, and to have these placed before them in a more popular form than in the quartos filled with figures, in which the observations themselves, and elaborate investigations founded on them, are printed. Their wishes in this respect, which were certainly most reasonable, were communicated to me, as the Superintendent of the Colonial Observatories, several months ago by my colleagues in the administration of the affairs of the British Association; and in accordance with their representation I undertook at our meeting last year at Hull, to prepare, for the present meeting, a report "On some of the results which had been obtained by means of the British Colonial Magnetic Observatories." In acceding to this request, however, I felt it right to state my full belief that this would be the first moment at which such a report could be presented without being liable to the charge of being premature. The subject and the occasion required that no conclusions should be stated but such as were, at the least, tolerably assured by concurrent evidence drawn from the different quarters from which corroboration might be sought; and this implied not alone the completion of processes of reduction to which the observations from the different observatories must necessarily be submitted, but also the additional labour of a coordination of the results obtained in different parts of the globe. The time, indeed, is yet far distant at which anything like a complete view can be taken of what is capable of being elaborated from the immense mass of materials accumulated in the last few years; but it is possible that the time is arrived when a first and partial report might be made which may not be altogether unsatisfactory.

I have said that the request made to me at the Hull meeting was to prepare a report to be included in the volume containing the record of this year's proceedings, and as is usual in such cases, to form the subject of a *sectional* communication. It has since been stated to me by the gentlemen whose office it has been to prepare the arrangements for this meeting, that a communication made to the Association on a subject on which it has taken so strong an interest, would be preferably made to the members of the different Sections united at an evening meeting. Now it has long been the cherished custom of our Association that its members should undertake cheerfully, and without hesitation, whatever duties may be allotted to them; and however I may reasonably distrust my own suitability for so prominent a position as that which I am placed in, I have been sensible that I could not with propriety decline it. It would, indeed, ill become your General Secretary to depart himself from an obligation which he has so frequently urged on others; and assuredly there is no one who has had more experience than I have had, that the person who does his best to discharge the duty assigned to him may feel sure of receiving from you the fullest and most considerate indulgence.

In considering then how I might most profitably use the opportunity which has been afforded me, I have thought that by confining myself to some one branch of the inquiry, I might hope to be able to convey, in the time to which an address of this nature must necessarily be limited, a more satisfactory notion of what is in progress of accomplishment, than if I were to enter upon a more extensive field; and I have selected as the topic most likely to interest the members of the Association generally, the evidence which we think we have acquired of the existence of a direct relation between the small periodical magnetic fluctuations which are obviously superimposed upon the mean state of the earth's magnetism, and the two other bodies of the solar system, the sun and the moon, which, if magnetism be a cosmical and not simply a terrestrial agency, might be expected to afford some indications of such a relation.

Commencing, therefore, with the Sun;—the first point to which I will direct your attention is the change which is found to take place in the diurnal variation of the needle *in different months of the year*. To make this the more clear, it is, perhaps, desirable that I should first give you a brief explanation of the diurnal variation itself. It was long since observed that a magnet suspended horizontally, a compass needle for example, undergoes in the course of every day a small variation in its direction, returning at the end of the twenty-four hours to the position which it occupied at their beginning. This is sometimes called *horary* variation, because the direction varies at the different *hours* of the day, and sometimes *diurnal* variation, because its period, or the cycle in which the variation is completed, is that of a solar *day*. Although there is still much that is obscure in the mode in which the sun may produce this periodical fluctuation in the magnetic direction, we are at no loss to recognize the sun as its primary cause, not only from the circumstance that its cycle or period coincides with that of a solar day, but also from the fact that the same changes of direction are found to occur at different places on the globe situated under different meridians, at the same (or very nearly the same) hours of solar time at each of those places. Thus, for example, in England, the north or marked end of the needle points to the extreme west of its daily movement when the sun is about two hours past the meridian, and the same thing is found to take place at the same hour of *local* time over the whole of Europe, although, as you are all aware, the absolute time corresponding to the same solar hour in the eastern and western parts of Europe is very different. The diurnal variation having thus its character dependent on and determined by the *solar hour*, we have this warrant for regarding the sun as its primary or original cause.

It has also long been known as a general fact that in Europe the amount of the diurnal variation is greater in summer than in winter, a fact which found a ready explanation in the prevailing opinion which ascribed the magnetic variations to thermo-electric causes, or to some other less definite modes of operation of variations of temperature, and which were naturally supposed to act with greater intensity in summer than in winter, inasmuch as the diurnal variations of temperature are greatest in summer; yet there were not wanting, even in the last century, observers in England who remarked that the increase of the diurnal variation in summer by no means coincided with, but considerably preceded, the period of the greatest summer heat, and also the period when the variation of temperature in the course of the day was greatest. But their remarks appear to have had but little weight in opposition to a favourite hypothesis, and it has remained for the far more extensive, more varied and more decisive conclusions derived from the observations of the British Colonial Observatories to generalize the phænomena, to manifest their utter irreconcileability with the explanations which would ascribe the change in the amount of the diurnal variation in different parts of the year to *local variations of temperature*, and to show that the true explanation must rather be sought in some more *direct* action of the sun on the magnetism of the earth.

I shall endeavour to make this clear to you by a graphical representation which will require a few words of preliminary explanation. The part of the general phænomenon of the diurnal variation to which I desire specially to direct your attention, is its alteration in character and amount in different parts of the year and in different parts of the globe. This part of the phænomenon admits of being viewed separately; the mean diurnal variation in the year, the mean in fact of all the months, constituting, as it were, an horizon or a zero-line, in comparison with which the difference which takes place in the diurnal variation in the different months may be shown, and the attention may thus be brought to bear more immediately and more exclusively upon what may be not inappropriately termed the *annual variation* of the diurnal variation. It may be shown with the greatest simplicity for any particular station by lines which exhibit for every month of the year the difference at each hour of the day between the mean diurnal variation of the whole year and the mean diurnal variation in that particular month; and by comparing the alterations which we find to take place in the different months at stations very widely separated from each other on the surface of the earth, and strongly contrasted with each other in regard to all those physical circumstances of temperature, &c. which are dependent on and vary with geographical position, we are enabled to test decisively the question whether those alterations are due to local circumstances, or are the result of some general cause affecting in the same way, and to the same amount at the same time stations thus widely separated and contrasted.

When the lines which thus represent the differences between the mean diurnal variation in the year, and in each of the months of the year, are drawn, they are at once seen to separate themselves into two well-characterized groups, one consisting of the six months when the sun is north of the equinoctial line, and the other of the six months when he is south of the equinoctial line. This is found to be the case alike at stations within the tropics and at stations in the temperate zone, and not in one hemisphere only, but in both hemispheres.

In every case the six months from April to September, and the six months from October to March, forming the two distinct groups, may be represented by mean *semiannual* lines from which the individual months composing the respective groups differ comparatively very slightly, whilst the two semiannual lines, as compared with each other, exhibit very marked distinctive characters, particularly at the hours when the sun is above the horizon; and these characters are essentially the same in all the varieties of geographical position which I have enumerated.

For the purpose of illustrating this remarkable fact, for the knowledge of which we are entirely indebted to the Colonial Observatories, I have placed in a diagram * the corresponding phænomena at St. Helena, an island in the middle of the ocean and within the tropics,—at Toronto in Canada, in the interior of a great continent, in 43° north latitude,—and at Hobarton in Van Diemen Island, in 43° south latitude. The lines in this diagram are in each case drawn from five years of hourly observation. The plain or black line distinguishes in each of these three figures the phænomena of the same period of the year, namely the six months from April to September; and the dotted line the other semiannual period, viz. from October to March. The horizontal line in each figure is the mean diurnal variation in the year, and the upper side of the horizontal line corresponds in every case to an easterly, and the lower side to a westerly deviation from it. In viewing these three figures, it is scarcely possible to doubt that they represent substantially one and the same phænomenon. The magnitude and the inflections of the curves are not indeed absolutely identical, but they approach so near to it, that we may well suppose the small differences to be very minor modifications, which may some day receive their explanation in minor modifying causes.

Now, phænomena so nearly identical in character and amount, and yet produced simultaneously at stations so widely dissimilar in geographical position and climatic relations, must have other causes than the very dissimilar variations of temperature which take place at those stations in the course of the year. Situated in opposite hemispheres, the summer of Toronto is the winter of Hobarton, and *vice versâ*; whilst at St. Helena (in the tropics) the distinction of summer and winter almost ceases; the sun being vertical twice in the year, viz. in February and November, and the epochs of maximum and minimum of temperature being very different from those at either of the extra-tropical stations. The sun's passages of the equator from north to south at the September equinox, and from south to north at the March equinox, are obviously the approximate epochs of transition from one class of phænomena to the other, alike at each of the three stations. The influence of the epoch is the same, and similar effects are produced, whether the station itself be north or south of the equator, and however diverse may be its climatic or its magnetic conditions. The three stations include a difference of latitude of above 86°, and a difference of longitude amounting to nearly half the circumference of the globe. It is difficult to resist the conclusion that an effect so general and so simultaneously produced points to a direct action of the sun upon the magnetism of the earth.

---

* Reproduced from the "Proceedings of the Royal Society," May 18th, 1854 (vol. vii. No. 4. p. 78.).

Now as to the precise epoch when the phænomena pass from the representation which is given by one of these curves into the very dissimilar phænomena of the other semiannual curve:—The separation of March which is in the one group from April which is in the other, and of September in the one group from October in the other, suffices to point generally to the sun's passage of the equator as the epoch of transition. But by taking our mean representations for shorter and more critical periods than monthly ones, (seeing that the equinoxes occur nearer the middle than the end of their respective months,) we are able to press the identification still closer, and to ascertain that the mean of the three weeks from the 1st to the 21st of September, being the three weeks immediately preceding the day of the September equinox, scarcely differs sensibly at any hour of the day from the semiannual mean of the preceding half-year, and consequently that the phænomena of that semiannual group have undergone no sensible change when a mean is taken corresponding to the tenth or eleventh day before the equinox. On the other hand, when a mean is taken corresponding to the three weeks succeeding the day of the equinox, namely the last nine days in September and the early days of October, of which the mean corresponds to the 10th or 11th day after the equinox, the transition from the character of the preceding six months has not only commenced, but has already advanced very far towards its completion; and by the middle of October is quite complete, as the line corresponding to the middle of October exhibits no trace whatever of the semiannual characters which ten days before the equinox had undergone no modification.

To recapitulate;—the mean line corresponding to the ten or eleven days before the equinox exhibits no trace whatever of the commencement of a change. The mean line corresponding to ten or eleven days after the equinox exhibits the change as having commenced, though not yet complete. The mean line corresponding to twenty-five days subsequent to the equinox (viz. the mean line for October) exhibits the transition fully completed. Such are the facts at the September equinox. A similar investigation in the case of the March equinox shows in the same way no trace of change ten days before the equinox; and the change commenced, but incomplete, at an equal period after the equinox. Apparently the progress of the change is somewhat more tardy in the March than in the September equinox. In both cases we have the indication that the commencement of the change synchronizes with the equinox, but that a certain interval of time, a few days more or less, is required for its completion. This appears analogous to the change which is operated in the induced magnetism of a ship, when she changes her geographical position and by so doing changes her position also relatively to the inducing cause, which in the case of the ship is the terrestrial magnetism. It has been found that in such cases the induced magnetism of the ship begins to change when the change in her position commences; but that an interval of time is required (variable partly with the rapidity and other accidents connected with her change of position, and partly also with the degree in which the iron she contains is susceptible of immediate magnetic change) before the change is completed, and her induced magnetism is again in accord with its inducing cause*. We have no reason to suppose that the effect of any external inducing cause acting on the magnetism of the earth would be dissimilar from that which we observe to take place in the iron of a ship. When the magnetic heterogeneity of the materials at the surface of the earth is considered, the supposition can scarcely be thought an unreasonable one, that the change which may be operated in the earth's magnetism by the sun's passage of the equator, supposing the sun to have a direct magnetic influence on the earth, may commence with the epoch of the passage, but may not be completed until a few days subsequent to it.

---

* Phil. Trans. 1843, art. x. pp. 152, 153; *ibid.* 1844, art. vii. pp. 88, 99, and 117-119 *ibid.* 1846, art. xviii. pp. 340, 348, and 356; *ibid.* 1849, art. xii. p. 177-186.

The next instance which I shall bring before you, in which a direct action of the sun appears to furnish a better explanation of the phænomena than an action operating through the agency of variations of temperature at the particular stations, is connected with the earth's greater proximity to the sun in one part of her annual orbit than in the opposite part. The orbit being an ellipse, the perihelion, or nearest approach of the earth to the sun, is in December, and the aphelion, or greatest distance from the sun, is in June, the amount of difference being about one-thirtieth of the mean distance. Now if there be any portion of the earth's magnetic force which is derived from the sun, it would be reasonable to expect that the intensity of that portion of the magnetic force should be greater in December than in June, and that this effect should be general over the globe, and exhibited of course in both hemispheres. It might well have happened, indeed, that the whole effect of the sun's magnetic influence might have been so small, that the difference in the effect due to a fluctuation of not more than one-thirtieth of the mean distance might have been insensible, or at least too small to be cognizable by our instrumental means. It does happen, however, that we do find by the observations that there is a small annual variation in the intensity of the magnetic force of the earth, and that it is shown concurrently by the observations in both hemispheres, viz. at Toronto and Hobarton, and that this variation coincides with the supposition which has been spoken of, being an excess of the force in both hemispheres in the month of December as compared with June, and nearly to the same amount in both hemispheres, viz. about two-thousandths of the whole magnetic force of the earth. This amount, though small, is not beyond the competency of the instruments or of the methods employed to determine it. It is the result at each station of several years of observation, but the excess in December is also shown when the whole period from which the mean is derived is broken into smaller portions. Had this result been obtained in one of the hemispheres only, say, for example, in the northern hemisphere, we might have supposed the increase in the magnetic force in December to be in some way connected with the winter's cold in that hemisphere; or if obtained in the southern hemisphere alone, a connexion might have been imagined with the summer's heat; but the same effect being found to take place at the same period of the year alike in both hemispheres, notwithstanding their opposite climatic circumstances, seems to remove it from the category of effects which can be ascribed to local variations of temperature, and to assign it a place amongst other concurrent indications of the direct magnetic influence of the sun.

But the most remarkable evidence, and the least intelligible upon any other supposition than that of a *direct* magnetic connexion between the sun and the earth, is furnished by the knowledge which we have gained through the British Colonial Observatories*, of the existence of a periodical fluctuation in the *magnetic disturbances* (or magnetic storms, as they are sometimes called), which corresponds in a manner and to a degree which can scarcely be imagined to be accidental, with an analogous fluctuation which recent observation has also discovered in those affections or obscurations of the sun's disc which are known to us by the name of the *solar spots*. It is unnecessary that I should occupy your time by entering into questions much discussed by philosophers, in regard to the probable physical nature of these spots; it will suffice to state the fact, that when the sun is viewed with a telescope, his luminous disc is found to be scarcely ever free from dark or ashy-coloured spots of irregular and variable outline, appearing and disappearing at uncertain times, and having no fixed period of duration. They are occasionally, though rarely, so large as to be visible to the naked eye when the brightness of the sun is partially veiled by thin clouds or by vapours. For several years past the solar spots have been the subject of careful daily observation, particularly in Germany, by which it has been learned that the number of the spots, and the space they occupy on the solar disc, vary considerably at different times, and that the variation is of a character which we can by no means regard as accidental, since it follows with great regularity a law of periodical alternate increase and decrease, continuous and progressive from a minimum to a maximum in a period which corresponds nearly with five of our years, and from a maximum to a minimum in a period of similar duration. Several such periods of alternate increase and decrease have now been observed, so as thoroughly to establish the fact and the regularity of its occurrence. The spots usually appear in groups, and to give a notion of the magnitude and the variation of their number at different times, it may be stated that in the years of minimum the number of distinct groups appearing in the year is usually between thirty and forty; whilst in the years of maximum the number is between 300 and 400. The years of maximum, since the solar spots have been subjected to this careful examination, have been 1828, 1837 and 1848; the years of minimum 1833 and 1843.

---

* Phil. Trans. 1852, art. viii. pp. 113–124.

Now, before we come to the parallel circumstances of a decennial periodicity in the magnetic disturbances, it may be desirable to premise a few words of general explanation respecting these phænomena, of which the greater part of our knowledge is so recent. When the Colonial Magnetic Observatories were established in 1840, little more was known of them than the fact, that at uncertain and apparently irregular times the magnetic direction and force were liable to be affected by seemingly capricious changes, sometimes of very considerable amount, and occasionally succeeding each other with great rapidity;—that these affections took place at one and the same time in different parts of the continent of Europe;—and that the changes which they induced in the magnetic direction and force observed within those limits, were generally simultaneous (in absolute time), and to a great degree similar. A connexion had also been inferred between the disturbances and the aurora borealis, from the circumstance that auroras of remarkable brilliancy had been frequently known to occur at times when the magnetic instruments were unusually disturbed. Now, the observations at the Colonial Observatories have, in the first place, extended and rendered more precise our knowledge of the generality of these phænomena. They have shown that parts of the globe most distant from each other are affected by them at the same time; but that when places thus simultaneously affected are very distant from each other, the effects at each may be very dissimilar. The most careful comparison with the variation of the meteorological elements has failed to establish the existence of any mutual connexion. Their duration has also been found to be as apparently uncertain as their occurrence, extending sometimes over three or four successive days without intermission. So far they have still appeared to justify the term *irregular* which had been originally applied to them. But on a more close and studious examination, and by adopting a process of investigation suitable for the purpose, the frequency with which disturbances of this unexplained character occur, and the aggregate amount of disturbance which they produce in the different months of the solar year and at the different hours of the solar day, were found to exhibit periodical laws of consistent and steady recurrence. In the case of the hours, for example, and confining the attention to a single station on the globe, it was found, by concurrent results in each of several successive years, that the greatest amount of disturbance occurred at a certain hour, and the least amount at another certain hour; and that this was the case both in the direction and the force, though not at the same hours; also, that the disturbances which increase the force had certain hours of maximum and minimum, and those which diminish the force certain other hours of maximum and minimum; and that, in a similar manner, the disturbances deflecting the needle in one direction had their fixed hours of maximum and minimum, and those deflecting the needle in the opposite direction had also their own particular hours. It need scarcely be said that laws which, as may easily be supposed, are somewhat complicated in their results, are not obvious in every disturbance that occurs; but certitude in respect to the stated regularity of their occurrence is obtained by the employment of the method which has been so fertile of late years in the establishment of so many natural laws, viz. the deduction of mean numerical values from a large body of observations, and the subsequent comparison of these with the mean values corresponding to distinct parts of the same. By the adoption of this method, the periodical fluctuation of which we are speaking is found to take place with great regularity at all the stations at which the investigation has yet been made. The progressions from the maxima to the minima and from the minima to the maxima are almost uniformly continuous in the results, even of each independent year; thus manifesting an existing connexion between the disturbances and the hours of solar time. By the same method, a similar periodicity is shown to exist in the disturbances occurring in the different months which constitute the solar year.

At all the stations where the investigation has hitherto been made, the disturbances are thus found to manifest periodical laws dependent on the solar hours and the solar months. The epochs of the maxima and minima of the several phænomena are not the same at different stations; and for the complete elucidation of the subject a greater number of stations will therefore be required than those at which the examination has yet been made. But for our present purpose we have full and sufficient evidence, that whilst on the one hand the disturbances occur from time to time at intervals which are not marked by any other ordinary terrestrial phænomena with which we are acquainted, they manifest, at the same time, in their details a subordination to solar times which shows them to have a connexion of some kind with the sun. Now, if this connexion could be traced no further, it might be difficult absolutely to establish, that the effects, which have been thus described, were not in some way due to those variations of temperature which the sun occasions in the atmosphere and at the surface of the earth. The connexion, however, between the *frequency and the amount of the solar spots*, and the *frequency and amount of the magnetic disturbances*, to which I now proceed, appears to offer no uncertainty, and to admit of no question of this nature; for the most careful investigations by physicists of great eminence and experience have failed to discover the slightest influence of the variations of the solar spots upon the thermic conditions either of the atmosphere or of the earth. Until this connexion was observed, no correspondence whatsoever, though carefully sought, had been found between any other known phænomena, either cosmical or terrestrial, and the affections which we perceive to take place with so much regularity and to so great an extent in the solar disc. On this subject, therefore, I am now especially desirous to put before you the precise amount of the correspondence with the magnetic variations which has been discovered; since, if it should be confirmed by further experience, it may not unreasonably be expected to throw an important light on many matters of high scientific importance,—such as the nature of the solar spots themselves, the mode of action by which magnetic effects are produced by the sun upon the earth, and possibly even upon the nature of magnetism itself.

The observations employed in the investigation were the hourly observations made at two observatories, Toronto and Hobarton, the stations being in opposite hemispheres and nearly in opposite points of the globe. The observations commenced in the latter part of 1842, and were maintained for five years, terminating consequently in the latter part of 1848. Every observation occurring in these five years which exceeded a certain amount of difference from the mean value in the same month and at the same hour, was considered a disturbed observation, and being separated from the rest, these constituted the body of disturbed observations, which were made the subject of examination at each station. By assuming an arbitrary and somewhat large magnitude as the standard of disturbance, the observations separated were doubtless less in number than would have been the case had it been possible to have adopted an *absolute* criterion; but one and the same magnitude having been preserved as the standard in each of the years, the *relative* frequency and *relative* aggregate values in the different years were obtained, very approximatively at least, in their just proportions. At each station the disturbances were found to increase, both in frequency and in aggregate values, progressively from 1843 to 1848; the aggregate value of the disturbances in 1848 being, both at Toronto and Hobarton, about three times greater than in 1843. It happened that at the very time when a somewhat laborious investigation had conducted me to this result, I had before me, in the third volume of M. de Humboldt's 'Kosmos,' the results of M. Schwabe's observations of the solar spots from the year 1826 to 1850, then first made public for the portion subsequent to 1844, and I was immediately and most forcibly struck by the coincidence both in period and epoch with the variation announced by him in the frequency and amount of the spots, of which a minimum was also in 1843 and a maximum in 1848. The hourly series of observations at Toronto having been preceded by a two-hourly series in 1841 and 1842, a similar examination was made of those years when it was found that the magnetic disturbances as well as the solar spots increased in going backwards from 1843. A similar examination has since been made by Captain Younghusband, recently my assistant at Woolwich, of the disturbances at St. Helena and at the Cape of Good Hope, and the results have been communicated by him to the Royal Society. Though the series of observations from which the results are derived was less extensive than at Toronto and Hobarton, ceasing at the Cape in 1846 and at St. Helena in 1847, the year of minimum disturbance at both the latter stations is 1843, and the increase is progressive to the close of the series.

Having this striking indication of a connexion between certain of the magnetic variations and the solar spots, limited unfortunately in respect to time by the termination of the observations at the Colonial Observatories, but remarkably accordant within those limits, it was natural to examine whether any similar variation was discernible in other terrestrial magnetic variations, which, like the disturbances, were regulated by solar hours; and I had soon the gratification of perceiving that the mean diurnal variation in each year (that of which I spoke in the early part of this exposition) exhibited a *variation in its amount in* DIFFERENT YEARS, which, like the disturbances and the solar spots, had a decennial period; that the epochs of minimum and maximum were also 1843 and 1848; and that in the two broken half-periods, the one previous to 1843 and the other subsequent to 1848, the same law of alternate progressive increase and decrease was manifested. In the conclusion of which I am now speaking, viz. the decennial fluctuation in the magnitude of the diurnal variation, I was, without being aware of it, preceded (in one of the magnetic elements, viz. in the declination) by our associate, M. Lamont, who had perceived it in the examination of the observations of the same years made in the Magnetic Observatory at Munich, but to whom it is probable that the account of M. Schwabe's observations of the periodicity of the solar spots was not then known, for otherwise I have little doubt that the coincidence would have attracted his attention.

From the Munich observations, the years 1843 and 1848 were also found to be the epochs of minimum and maximum in the magnitude of the diurnal variation of the declination dependent on the solar hours. I have since ascertained that these are also the years of maximum and minimum of a periodical fluctuation in the diurnal variation of the *inclination* of the magnetic needle and of the *intensity of the magnetic force* of the earth, as well as of the horizontal direction of the needle, at all the four stations at which the Colonial Observatories were established.

It is fully admitted, that before so important a fact as that of a correspondence in period and epoch between affections of the luminous disc or photosphere of the sun, and magnetic variations observed upon the earth, can be regarded as positively established, it will require to be confirmed by observation of the recurrence of the coincidence in several successive periods. But so far as the limited duration of the Colonial Observatories has permitted the comparison to be made, the coincidence thus brought by their means into public view, and submitted for a further examination, (which it cannot fail to receive,) has been manifested alike by *every one of the magnetic variations, which, by their dependence on solar hours, are traceable to the sun as their primary cause.*

Had the observatories borne no other fruit of an analogous description but that which I have thus brought before you regarding the SUN, they would have been entitled to the distinction of having at least indicated a coincidence between terrestrial magnetic variations and the phænomena of one of the heavenly bodies, which coincidence is characterized by the absence of any discoverable corresponding variations of temperature, or terrestrial affections of any sort, through whose agency or intermediation the magnetic changes might be produced. But the evidence in regard to the sun does not stand alone. In the case of the MOON also, we have been able to trace unquestionable evidence of the existence of a magnetic variation at the surface of the earth, dependent on a change in the moon's place relatively to the meridian of the place of observation at the different hours of the day, and therefore appropriately named the *lunar diurnal magnetic variation*. I need scarcely remark, that in the case of the moon, any supposition of the intermediation of temperature as the producing cause of the terrestrial magnetic affection would be, if possible, even more improbable than we appear to have reason to infer it to be in the case of the solar spots.

In speaking of the lunar magnetic influence, however, it is proper to premise that the Colonial Observatories cannot claim the distinction of having been the first to make it known; although it is probable that the knowledge which has been gained by their means, of the different effects which the moon's magnetic influence produces in different parts of the earth, cannot but contribute in a very material degree to that generalization of the phænomena to which we must look before we can expect to have a satisfactory knowledge of what the moon's magnetic state is. Without entering into particulars, for which this would be an unsuitable occasion, I may perhaps succeed in acquainting you by a few words with the method by which another of our associates, M. Kreil, Director of the Magnetic Observatories, first at Milan and afterwards at Prague, and now Superintendent of the Magnetical and Meteorological Establishments in the Austrian States, succeeded in tracing the existence of the lunar influence of which we are speaking, and which, with some modifications, I have also employed for a similar investigation of the observations collected at the Colonial Stations. The method, as employed for the Colonial Observatories, is as follows:—The precise direction to which the magnet points is observed, as I have already noticed, at every hour. These are hours of *solar* time, and differ from hours of *lunar* time, inasmuch as the moon takes, on the average, about 24 hours and 40 minutes of solar time from her passage of the meridian on one day to her passage of the meridian at the same place on the next day. A lunar hour is therefore somewhat longer than a solar hour, and observations made at regular intervals of solar time do not exactly correspond to any regular series of lunar hours. But the twenty-four observations made in the course of a solar day may be so arranged that each observation may be placed in a table under the lunar hour to which it is nearest in point of time; and in this arrangement the greatest error that can take place in the classification of the observations, according to their corresponding nearest lunar hour, will not in any case exceed 30 minutes. If therefore the whole of the hourly observations for several years are thus arranged, a mean of the observations at each lunar hour, taken for each lunation or period of about twenty-eight days, or for several such periods combined, will show the relative direction of the magnet at each of the 24 lunar hours, or say at 0 hours when she is on the upper meridian, at 12 hours when she is on the meridian below the pole, at 6 hours and 18 hours when she is 90° on either side of the meridian, and at the intermediate hours when she corresponds to the intermediate hour-angles. Now when this is done, and the results during several lunations are grouped together, so that disturbing influences from other causes may be more effectually counterbalanced, and thereby eliminated, the magnetic direction is found to undergo a regular and systematic change in the course of the lunar day, having two epochs of greatest easterly-pointing and two epochs of greatest westerly-pointing between each two successive passages of the moon over the meridian of the station, the change in the direction being continuous and progressive from the easterly extremes to the westerly extremes, and *vice versâ*.

In consequence of the difference between solar and lunar time, the observations arranged under any one of the lunar hours must include every variety in the succession of solar hours, and consequently every variation dependent upon solar hours becomes compensated; or the observations may be used after the solar diurnal variation as well as the larger disturbances have been eliminated.

There are some peculiarities in this lunar diurnal variation which are worth adverting to even in so general and cursory a notice as the present;

they will probably conduce (with others discoverable by investigations still in progress) to a more intimate knowledge of the magnetic state of the moon, and may then receive their explanation.

The two extreme easterly elongations take place at each of the three stations of Toronto, Hobarton, and St. Helena* (the Cape of Good Hope still remains to be investigated), at nearly opposite points of the hour-circle, as do also the two extreme westerly elongations; but at each station the elongations in the two directions are not of the same amount. At Hobarton and St. Helena, both in the southern hemisphere, the westerly elongations have the largest values, and at Toronto, in the northern hemisphere, the easterly (speaking always of the north or marked end of the magnet). The lesser elongations are in each case about two-thirds of the greater. There is also another well-marked feature of difference at the different stations, in regard to the lunar hour at which the extreme east and west elongations occur. At Toronto the easterly elongations take place almost exactly at the times of the moon's upper and lower culmination, and the westerly elongations at the intermediate lunar hours of 6^h and 18^h. At Hobarton the westerly elongations occur about two hours after the upper and lower culminations, and the easterly elongations about two hours after the lunar hours of 6^h and 18^h; whilst at St. Helena the westerly elongations occur about two hours before the culminations, and the easterly extremes about two hours before 6^h and 18^h. It is, perhaps, from such differences as these, in the effects produced by the moon's influence at different points of the globe, that we may most hopefully expect to obtain a more intimate acquaintance with the moon's magnetism, to which they appear to be ascribable. But before this investigation is entered upon, we have yet to learn the corresponding effects produced in the two other terrestrial magnetic elements, viz. the inclination and the intensity of the force, by processes which necessarily occupy much time, but are in progress.

I must not, however, omit to notice a very important fact, viz. that in the terrestrial magnetic variation occasioned by the moon, *there is not the slightest trace of the decennial period which is so distinctly marked in all the variations which are connected with the sun.*

In the endeavour which I have thus made to meet the wishes of those who considered that some account, however necessarily imperfect, ought to be now given of the progress which has been made in magnetic science, by the aid of the establishments which were so greatly indebted for their institution to the British Association, I have confined myself strictly to one branch of the inquiry, which I selected as being the most likely to interest the greater number of my auditors. Strictly as I have done this, and carefully as I have endeavoured to be as brief as the subject would permit, I still feel I have made a larger demand on your attention than I could have wished. I will only permit myself, therefore, in conclusion to remark, that the extension, to other bodies of the solar system, of forces which we perceive to be in action in our own planet, cannot be regarded otherwise than as one of the most important results which could be hoped for from the prosecution of a scientific research.

Of the material *substances*, solid, gaseous or liquid, of which the other bodies of the solar system are composed, whether identical or otherwise with those which we find in our own planet, we have extremely little knowledge; nor do we appear to be likely to increase it by any means of direct observation which we can anticipate; but it is otherwise in respect to the *forces* which bind the different parts of the solar system together in cosmical connexion. These open to us a field of research which is the more inviting because they appear to be regulated by laws of uniform action to the extreme limits to which their agency can be traced. It is possible, therefore, that laws which we may establish by means of phænomena within our own immediate sphere, may reach and explain the phænomena of other spheres which might otherwise appear to us veiled in impenetrable mystery; and in like manner, laws which we may first develope by studying them in the mutual relation which they produce between our own and other bodies, may possibly give us an earlier or a more perfect command than we might otherwise have acquired of their controlling agencies in our own planet. We have been long familiar with gravity as a force of this description, and with its extension to every part of the solar system, not to speak of the regions beyond. We have hitherto known magnetism only as a telluric force, of much less apparent simplicity than gravity, and greatly requiring a key to enable us to apprehend its laws, as well as its purposes in the general œconomy of nature. To improve our knowledge in these respects was the object of the Magnetic Observatories. But if, as we appear to have reason to believe, we are to view magnetism not only as a *telluric* but also as a *cosmical* force, the interest and importance of our inquiries regarding it must undoubtedly be viewed as greatly augmented.

---

* Phil. Trans. 1853.

Liverpool, Sept. 25, 1854.

POSTSCRIPT, *Sept.* 26, 1854.

If our highly valued member, Dr. Lloyd, had not been unfortunately prevented by, I trust slight, remains of illness from coming to Liverpool, and if my own voice and strength had permitted me, I had wished and purposed to have added, after the close of the above address, a few words. They would have been on the great services rendered by him towards the attainment of the data on which the above results are based; more especially by the great and important aid given by his ability, skill, and inventive genius to the instruments and methods of observation with which our Colonial Observatories have worked. A full explanation of these would be far too long, and quite needless; suffice it to say, that of the instructions from the Committee of the Royal Society which I have referred to, much the greatest portion is due to him; and besides this, his kind personal instructions were freely given to those officers who were the first directors of three out of the four Colonial Observatories. But more than all, it is *altogether* to him that we are indebted for the instrument by which the variations of the vertical component of the earth's magnetic force have been observed, without which the variations of the declination and of the horizontal force could alone have been fully ascertained, and the variations both of the inclination and of the total force could have been only imperfectly made known to us.—E. S.

ILLUSTRATIONS OF THE ANNUAL VARIATION OF THE DIURNAL VARIATION.

k line.—**Mean Semiannual** Diurnal Variation, March 22 to September 20. *Dotted line.*—The same, Sept. 22 to March 20.

Fig. 1.—St. Helena.

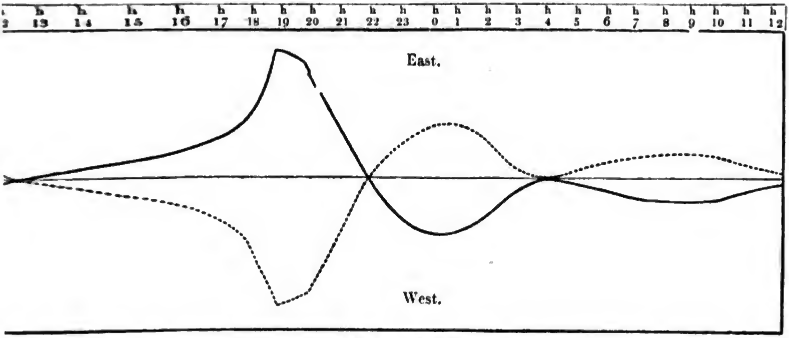


Fig. 2.—Toronto.

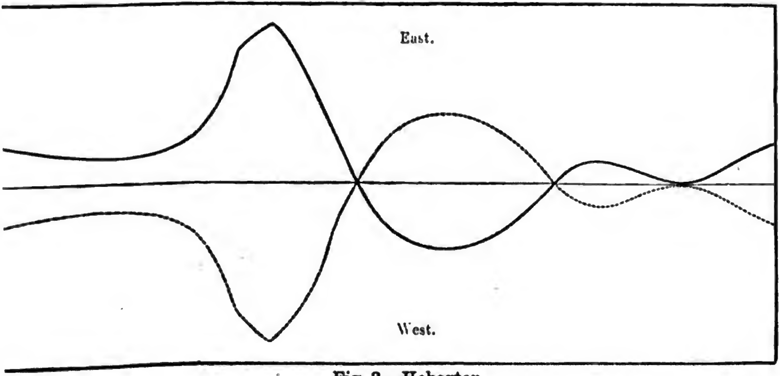
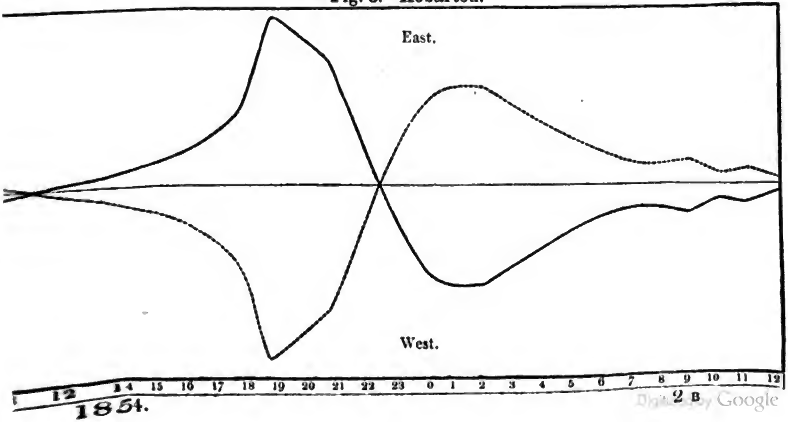


Fig. 3.—Hobarton.



Report of the Committee on Earthquakes, with their Proceedings respecting Seismometers constructed under the superintendence of Major James, R.E. By Col. Portlock, *R.E., F.R.S.*

It is necessary to precede the brief statement which I am about to make, by an equally brief notice of the object which, in the present case, the Committee desired to attain, and of the circumstances which had given rise to it. In 1848, at the Swansea Meeting, I brought under the notice of the Committee of Section A. the importance of observing and recording the earthquake shocks which are so frequent in the Ionian Islands, and the probability that the Board of Ordnance would be disposed to assist in such an undertaking, if applied to by the Association; by directing some of the many scientific officers of Artillery and Engineers stationed in the islands to make the inquiries, and by furnishing them with instruments for the purpose. As at that time Mr. Mallet was engaged in devising the best mode of making such observations, the Committee thought it prudent to defer such an application until the result of his experiments had been made known. Two valuable Reports of that most able investigator of earthquake phænomena were presented to the Association; but as no definite result had been arrived at in respect to instruments, I again brought the matter forward in 1852; and Colonel Sabine and myself were directed to communicate with the Master-General of the Ordnance on the subject. Col. Sabine accordingly wrote to the Master-General, and after consulting Sir J. Burgoyne, Major James, who had been entrusted with the superintendence of meteorological instruments, was directed to have a pair of Seismometers constructed, that they might be sent to the Ionian Islands. In 1853 the Earthquake Committee was re-established; and I was requested to act as the organ of intercommunication, in order to offer any necessary suggestions in respect to the construction of such instruments;—but I must turn for a moment from these proceedings to the object to be attained.

Of the ultimate cause of earthquakes we can only conjecture; but, whether the result of some impulsive action consequent on the sudden development of gaseous matter, or of vapour in a state of high elastic tension, or of any other source of pressure, causing the disruption or rending of the earth's strata, it seems now generally admitted that they are waves of vibration transmitted through the earth's crust from the focus of disturbance. If so, they may be expected to be transmitted in all directions, though the curve of the wave may be modified by many circumstances, depending on the different conditions, as to elasticity, of the transmitting medium; and will thus arrive at the earth's surface in such a manner, that the curve of the wave will intersect the curve of the earth's surface at angles varying with the position of the intersection as regards the centre of the wave curve. At any point of the line of intersection, the remaining force of the last vibration will therefore manifest itself in a direction which may be resolved into two forces —one vertical, and the other tangential;—the latter being progressive, as it were, on the earth's surface. The progressive component will increase in proportion to the vertical, according as the wave intersects the earth's surface at a more oblique angle, and *vice versâ*; so that it is essential to estimate the proportion between these elements in order to determine, or at least estimate, the position of the focus of disturbance. In order to effect this object, two modes might be suggested: namely, 1st. To measure the actual wave itself, as exhibited on the earth's surface by the amount of displacement, both vertically and laterally; 2ndly. The transmission of the wave into some more elastic substance, and receiving from it the final shock so as to determine the intensity of the remaining force. The former has been the system adopted,—directly, in the mode of solid pendulums, and indirectly, by that of liquid pendulums,—to use the term of Mr. Mallet, their proposer.

Immediately after the re-appointment of the Committee, I heard from Major James that he had adopted, more from necessity than choice, the form proposed and adopted by Prof. James Forbes; and that he had found it unsatisfactory, as a purely vertical force tended to produce a lateral movement; and this seems a necessary consequence of a construction which introduces a flexible spring or wire between the pendulum and its support,—as this spring bends, and then, in recovering its straightness, produces a lateral vibration in the pendulum; but as an instrument had been made, it appeared prudent to submit the proposition to the Committee, as one of inquiry, as to the possibility of modifying or improving this specific construction; and I offered a suggestion as to a disc of metal, supported on a conical pillar, and armed with a pointer at top, as a construction which might avoid the disturbing influence of the vertical component. Prof. J. Forbes made some slight modifications in this construction; and wrote that he thought it might be advantageously adopted for determining some forms of the possible movements consequent on earthquake disturbance. As such, I sent it to Major James, advising him to use his own discretion, as it would be better to have two of the first construction of Prof. Forbes, than one of it and another of the disc pattern. He, however, had two disc Seismometers constructed, altering, for convenience sake, the mode of suspension, so as to enable the instrument to mark the angular movement below rather than above, as in my suggestion. His proposition to do this I also submitted to several members of the Committee; but receiving no suggestions for change,—and indeed from Mr. Mallet a reiteration of his former opinion, that no solid pendulum could be of any use,—I saw no reason to interfere further with the construction; and the instruments are now before the Section.

Before making any further observations on this part of the subject, I will allude shortly to the liquid mode of registration—namely, that proposed by Mr. Mallet in the "Admiralty Manual." This is by bent tubes, ⅜′ diameter, one leg being vertical and closed, the other horizontal and open, each limb having about 6″ of mercury at the bend. Now, a pointer of cork being introduced into the open end, a sudden lateral shock would cause the mercury to displace the cork, which would thus mark the extent of the movement. Four such tubes joined together, and facing N.S.E.W., would of course indicate the particular direction of the shocks. An inverted syphon tube, upon the same principle, Mr. Mallet also suggested for measuring the vertical shocks. Another instrument, on the same principle, is described, by Dr. Daubeny, as the invention of Cacciatore, of Palermo, and is stated by Frederic Hoffman to have been used for determining the direction and intensity of earthquake shocks in Sicily. It is a circular disc of wood, ten inches in diameter, with a smooth bottom and surrounded by a rim with eight holes: outside of the rim is a circular wooden projection, with eight grooves, corresponding to the holes, and intended to convey the mercury to the receivers or cups placed below them. In this arrangement a purely vertical shock would be marked by a similar quantity in each cup; but a vertical and horizontal would complicate each other. I do not here allude to the more elaborate mode proposed by Mr. Mallet, with the aid of a galvanic battery, as he is still pursuing his inquiries with a view to the future determination of a more perfect instrument; but I will observe, that it appears to be the opinion of several of the Committee, that the difficulty is much increased by endeavouring to measure all, or even several, of the elements of great shocks, by one instrument. It would seem, therefore, wise to keep the observations separate; namely, that for time, by itself; for vertical direction, and intensity of force in that direction, by itself; and for progressive direction and intensity, by itself.

Supposing only the time observed, how interesting would be the fact, that in a long line subject to such frequent disturbances, some were common to two, some to three places, and so on; and, in like manner, that the place of greatest disturbance should be found to shift, being, for example, in the Ionian Islands, at one epoch at Zante, at another at St. Maura, and so on! At present only great shocks are noticed, but in such regions many minute shocks might intervene between them. The vertical and the horizontal intensities, or the extent of the vibrations in those directions, should also be recorded or observed separately; but the real difficulty in any ordinary instrument is to make it record more than one shock without re-adjustment: still, however, by making the periods of examination and adjustment at very short intervals, there can be little doubt that all great shocks would be very closely registered. The chances of overcoming the difficulties will be greatly increased by keeping each function separate; namely, the shock in its vertical component, the shock in its horizontal component, and the time of shock; and by due attention to any one of these functions, very much improved systems of registry may be devised. And it is probable even that a fitter method may be discovered for determining the intensity by some other means than the angular motion, even by using solid instruments. I hope, indeed, to obtain some data for this purpose by means of the vibrations in heavy guns, &c. at Woolwich: not, however, desiring to interrupt in any way the progress of Mr. Mallet's researches; though it is evident that simple and yet accurate forms of instruments, cheap in construction so as to be multiplied for as many places as possible, and easy of manipulation so as to be trusted to ordinary observers, are the present desiderata.

The disc instruments constructed by Major James, though conforming to the general principle suggested by me, as the organ of the Committee, are probably deficient in weight, and would, therefore, oppose too little inertia to a severe shock to preserve them from irregular oscillations; but as this defect can be easily remedied, they deserve a practical trial. Major James has also had constructed a simple pendulum for the same purpose, and another provided with a weight suspended by a spiral spring surrounding the rod of the pendulum, and attached to its upper end, the object of which is to register the vertical and horizontal movements at the same time:—a mode of determination which had also been suggested by Mr. Mallet. These instruments deserve also to be fairly tried, as they will unquestionably give valuable information on some, though not on all, the elements of this important subject; but it is hoped that, hereafter, those who pursue the subject will endeavour to perfect the observations of each element of the disturbance,—not, however, forgetting, that it is also desirable so to link them together, that every shock may be referred to its true epoch.

On the Influence of the Solar Radiations on the Vital Powers of Plants growing under different Atmospheric Conditions.—Part II.

By J. H. GLADSTONE, *Ph.D., F.R.S.*

SINCE I laid before the British Association my former Report, some of the experiments there detailed have been repeated, and the investigation has been pursued further in the same direction. I have the honour now to present the results which have been obtained.

The experiments about to be described were conducted, not as before at Stockwell, but in Tavistock Square, London. The locality was not quite so favourable to the growth of plants, but they had always the advantage (unless otherwise stated) of standing on tables at the windows of a large upper room having a south-east aspect, so that they obtained the full benefit of the morning and noonday sun. The apartment was never artificially heated, but in the winter time it must have been a few degrees higher in temperature than the external atmosphere.

The coloured bell-glasses described in the previous Report were made use of. I am now able to give a more accurate description of what solar rays were actually transmitted by them. The effects of the different glasses on the prismatic spectrum were as follows:—

Colourless glass. No perceptible difference from the normal spectrum.

Yellow glass. The red rays were cut off, but the line C was just visible in the orange-coloured region. The yellow and green portions of the spectrum were quite natural, except perhaps that they were rather more uniform in colour than usual; the blue was rather bright above the double line F, but there was very little illumination in the portion more refracted, and the violet rays were quite unseen. The lines D, E, *b*, and F were very visible.

Red glass. The spectrum consisted of two luminous spaces, separated by a broad band of perfect darkness. The one was of a red and orange colour, commencing between B and C, and apparently cut off by the dark line D. The other was faintly illuminated with an olive-green tint, commencing about the most intensely yellow part of the ordinary spectrum, and continuing to about *b* (which was barely visible), and then passing into a lilac hue, which gradually faded off, till it became imperceptible perhaps a little below the lines F.

Blue glass. The spectrum had a very singular appearance, consisting of several distinct luminous bands. First there was a reddish band of considerable brilliancy, occupying a space beyond that of the least refrangible portion of the visible spectrum. This was separated by a dark space from a very narrow but bright band somewhere near the line B. Its colour was very different from any of those of the normal spectrum, but perhaps it approached nearest to the orange. Then, after another dark space, came a bright yellow band of greater width, just above the line D, which, however, was not itself perceptible. The whole yellow portion of the spectrum was cut off, and there was no illumination till about midway between E and *b*, where a bright green suddenly appeared. This passed into a pale green, where there was very little illumination, but not perfect darkness, till at about F an intense blue appeared, continuing through the region of the violet, to the end of the most refrangible portion of the spectrum. The lines *b*, F, and G were very distinct, as well as some about *d* and H.

This analysis of the light transmitted by the various glasses, confirms the description previously given of their character, namely, that "The blue glass cuts off by far the greater portion of the luminous rays, but admits the chemical rays freely; it may also be considered as interfering much with the transmission of heat. The red glass, on the contrary, freely admits the calorific influence, but stops the chemical, whilst, like the blue, it diminishes greatly the luminous. The yellow again scarcely decreases the illuminating power of light, but almost destroys its chemical action."

The series of experiments on hyacinths, which was described in the last Report, was repeated with additional attention to the effects of partial or complete darkness. The large colourless, blue, red, and yellow bell-glasses were employed, together with a partially obscured colourless shade, and a partially obscured yellow shade; and another experiment was instituted under a glass shade placed in a large box, so that the light was completely excluded, except when for a few moments the lid might be removed for the purpose of observing the progress of the experiment. As in the preceding experiment, the bulbs were all of the same description, of a healthy appearance, and of about the same size. After being weighed, they were placed as before on the top of colourless glasses, filled with pure water, and covered with the large bell-jars. In this case the jars were themselves placed upon the perforated boards, with the arrangement of tarlatane, &c., mentioned in the previous paper. The experiments were commenced on December 10th; each of them was successful; the results accorded in some points with those of the former occasion, but in other respects there was considerable discrepancy. The experiments made in partial or complete obscurity were perhaps the most instructive.

Rootlets began to appear immediately under the dark shade, and on December 26th, that is, after sixteen days, they were found to be 1½ inch in length. They grew rapidly, and were very numerous. They were thin and long, and appeared to have little strength. Under the obscured colourless and obscured yellow glasses, the rootlets also began to grow quickly, becoming three-quarters of an inch long in a fortnight's time; while under the blue and colourless glass exposed to the full power of the light, the rootlets did not so quickly attain any length, and in the same space of time there was scarcely anything observable under the red or yellow glass. The roots continued to grow under the obscured glasses until the beginning of February, but they arrived more rapidly at maturity under the influence of the white and blue light. Under the red shade the roots never attained any considerable length, but they were stout and strong. Under the yellow shade there was scarcely any growth below the bulb until near the end of January, when a few long straggling roots made their appearance. This is very accordant with the effect that was observed during the previous season to be produced by the coloured glasses. This shows that the development of the root takes place most rapidly in the absence of all solar radiations; that partial obscurity is also favourable; that the less refrangible rays of the spectrum had especial power to retard their growth, and that the luminous and calorific rays had peculiar actions of their own.

As to the leaves, little appearance of growth was observable in any of the hyacinths till December 26th, when those under the colourless and blue glasses began to shoot; that under the red glass followed very soon, while those under the yellow and the partially and wholly obscured glasses gave no sign for about three weeks longer. The leaves grew most rapidly in the blue light. The following comparisons of the length of the leaves under the various luminous influences may be interesting. They were taken on the 13th and 21st of February, when all the plants were in vigorous growth, but not one of them had flowered, and on March 22nd, when the plants had attained their full maturity.

	February 13.	February 21.	March 22.
Under the colourless glass	4 inches	6 inches	11 inches
„ blue „	6 „	8 „	14 „
„ red „	3 „	5 „	11 „
„ yellow „	2 „	3 „	8 „
„ obscured colourless glass	3 „	3½ „	10 „
„ obscured yellow „	3 „	3½ „	12 „
„ dark glass	3 „	4 „	10 „

The flower-stalk very nearly kept pace with the leaves. There was a greater difference in the periods at which the petals opened than in the former series of experiments; those under the blue and colourless glasses took the lead, and those under the partially obscured glasses were the last. They opened for the most part during the last days of February. Under the red shade two flowers grew, but they were thin and straggling: the same was the character of the plant that grew in the dark. There were two flower-stalks under the partially obscured colourless glass; they were never developed, however, but were found at the end of March losing their colour and becoming rotten. The experiments were terminated on March 22nd, excepting the two under the partially obscured glasses, which were allowed to continue till the 30th. The respective lengths of the flower-stalks were then,—

Under the colourless glass....................	13	inches.
„ blue „	13	„
„ red „	12·5	„
„ yellow „	12	„
„ obscured colourless glass	4	„
„ obscured yellow „	10	„
„ dark „	13	„

The hyacinths having been removed from the water in which their roots had been immersed, were suffered to dry in the open air of the room for twenty-four hours, and were then weighed.

	Primary weight of bulb.	Fully developed plant.	Actual increase.
Under the colourless glass	936 grs.	1494 grs.	558 grs.
„ blue „	862 „	1472 „	610 „
„ red „	856 „	1438 „	582 „
„ yellow „	1008 „	1406 „	398 „
„ obscured colourless glass	873 „	1591 „	718 „
„ obscured yellow „	872 „	1556 „	684 „
„ dark glass	763 „	1205 „	442 „

If, instead of observing the actual increase of weight, we compare the original weight of the bulb with that of the fully developed plant, we obtain the following proportions:—

Under the colourless glass as	1000 : 1596.
„ blue „	1000 : 1708.
„ red „	1000 : 1680.
„ yellow „	1000 : 1395.
„ obscured colourless glass as	1000 : 1822.
„ obscured yellow „	1000 : 1784.
„ dark „	1000 : 1579.

This increase in weight in the growing hyacinth is due to the fixation of water, and not to the decomposition of carbonic acid in the atmosphere; at least a smaller bulb which was placed under a colourless shade, and cut off from the external atmosphere by the edges of the glass dipping into water, grew and flowered perfectly well; and when removed from the shade on March 22nd, and dried as the others were, it gave the following weight:—

Primary weight of bulb.	Fully developed plant.	Actual increase.
625 grs.	1167 grs.	542 grs.

or as 1000 : 1867,—

a larger proportional increase of weight than in any of the other experiments, the actual increase being about the same as that of the other plant which grew under the colourless glass.

The leaves that grew in the dark were perfectly etiolated, excepting just at the tips, where they showed the normal green colour gradually shading off as it descended. The leaves that appeared in the experiments with the obscured glasses, were somewhat lighter in tint than those growing where the direct radiance of the sun could find access. The character of the light, under which the flowers were grown, did not affect their colour at all in the way that might have been expected. They were all, as on the former occasion, of an equally deep purple; even that which grew in complete darkness exhibited the same depth of colour in all the petals, excepting a few of the lower ones. The purple flower under the colourless glass when fading turned to red; and this was also the case under the blue and yellow glasses; but the flower under the red glass showed no trace of red colour, even when it had quite shrivelled up, nor was there any such change in the intense purple that appeared where light was excluded.

In such experiments as those just detailed, it is difficult to separate what might be the effect of adventitious circumstances from the genuine effect of the diversity of light. However, we may safely remark in the experiment which was conducted in perfect obscurity—the rapid and abundant growth of thin rootlets, the general healthiness of the plant, the non-formation of chlorophyll, but the production of the colouring matter of the flower, not altered in its subsequent fading. The two experiments performed in partial obscurity appeared as closely alike as possible, until the last week, when one of the plants died. The fact that the chemical rays were cut off from one of them, made no apparent difference. Their backwardness, as compared with the other flowers, was probably owing to their having been placed in a position which was somewhat colder than that of those which received the full light of the sun. The effects of obscurity were observable in them in a modified manner, and they both absorbed much more water than the other plants did. The effect of the red glass in interfering with the length of the roots, and in producing a badly developed plant, was observed both in this and in the former series of experiments. Its power of preventing the reddening of the faded flower is remarkable. The effect of the yellow glass in causing the rootlets to be few and straggling, and in diminishing the absorption of water, was also noticed in both instances. The blue glass appeared to favour the development of the hyacinth.

That the green colouring matter of leaves requires the action of light for its production, has long been universally admitted, and Dr. Daubeny has shown that it depends on the luminous ray. From analogy, and from a few observations by Davy, Senebier, and others, the same has been assumed to hold good in respect to the colours of flowers, but the purple hyacinth bears other witness, and should induce us to doubt this too hasty conclusion.

A number of experiments on germination were made during the spring.

The seeds experimented on were those of the wheat and the pea; and in every case both were employed, in order that if there should be a different effect of light on the monocotyledonous and dicotyledonous plants, it might be seen. Seeds of familiar plants and of great commercial importance were chosen, as it was supposed a greater degree of interest would naturally attach to experiments on them, and it might happen that some observations of value to the agriculturist might be made.

The first series of experiments was made in common air, under the seven various influences of coloured light and obscurity which have been described in treating of the hyacinths. The coloured shades were arranged before the windows, as described above, and they dipped into plates of water, so that throughout the experiments they were filled with an unchanged atmosphere, saturated with moisture. Twelve grains of wheat and twelve peas were taken for each separate experiment, and their weight was noted while they were still dry. They were placed on bricks within the glass shades, the bricks standing in the water, so that they were always damp. Another arrangement was made, similar to that just described in every particular, except that the seeds were in the open air of the room, without any cover.

The experiments were commenced on April 21st. The following is a table of the weather, and of the temperature taken in the shade at mid-day during the time that the various experiments with peas and wheat continued:—

April 22.	cloudy		May 15.	fine	69°
„ 23.	do.		„ 16.	variable	65
„ 24.	do.		„ 17.	fine	66
„ 25.	variable		„ 18.	cloudy and wet	64
„ 26.	do.	60°	„ 19.	fine	66
„ 27.	wet	57	„ 20.	do.	67
„ 28.	variable	56	„ 21.	....	...
„ 29.	do.	56	„ 22.	cloudy and wet	64
„ 30.	....	...	„ 23.	fine	65
May 1.	wet	55	„ 24.	variable	63
„ 2.	variable	55	„ 25.	fine	66
„ 3.	do.	59	„ 26.	do.	67
„ 4.	fine	61	„ 27.	wet	63
„ 5.	variable	63	„ 28.	....	...
„ 6.	cloudy	60	„ 29.	wet	63
„ 7.	....	56	„ 30.	do.	63
„ 8.	variable	...	„ 31.	fine, but cloudy	65
„ 9.	wet	60	June 1.	fine	66
„ 10.	fine	58	„ 2.	wet	63
„ 11.	cloudy	62	„ 3.	fine	65
„ 12.	fine	60	„ 4.	....	...
„ 13.	cloudy	64	„ 5.	cloudy	63
„ 14.	....	65	„ 6.	do.	63

We shall first consider the growth of the wheat; afterwards that of the peas; and then compare the two.

On April 26th the corn-seeds were found just beginning to burst under all the seven glasses, those under the obscured yellow being the most advanced. Further growth was visible the following day under that glass, and also under the obscured colourless, and the yellow, though the plume did not appear in any case till the 29th. On May 1st the radicles under the colourless and blue glasses were of considerable length, but those under the obscured colourless and the red were longer, while the longest were under the yellow glass. On April 29th plumes appeared under the red and obscured colourless glasses, and in the dark. They appeared two days later under the colourless and the blue, while the seeds under the obscured yellow had an unhealthy look. On the 4th of May long etiolated leaflets were found in the dark; under both obscured glasses the wheat had also shot up long leaves; under the red and yellow glasses there were plumes of 1 or 2 inches in length; while under the colourless and blue they only reached half an inch. The wheat-plants under the colourless glass then began to grow more rapidly, and soon gained the advantage of those under the blue, and still more of those under the red. On the 8th they measured 3 inches, while those that had grown in the dark measured 6.

On the 12th the wheat-plants were more fully examined, and drawings of them were made. It was then found that under the colourless glass ten of the twelve seeds had grown. They presented very uniformly the appearance given in Plate IV. fig. 1,—leaves erect, of a full green colour, from 4 to 5 inches in height, roots long and thin, five in number, taking firm hold of the brick. They had no side rootlets, but were fringed with hairs. Under the blue glass, the wheat appeared like that under the colourless, but smaller. Under the red, only four plants grew like fig. 1, and they were not so regular in form, size, or general aspect as those under the colourless glass. Four others had grown somewhat like fig. 2, where there was this peculiarity,—the green stalk had been unable to burst the transparent membranous sheath, and had forced itself out in a kind of loop, at that part where the sheath sprung out of the seed. The roots were generally flaccid. Under the yellow glass, the radicles were so strong, and bent so decidedly downwards, that they raised the seed completely on end: they were thickly covered with hairs. The stalks were short and strong, and generally bent in the manner represented in fig. 3. Under the obscured colourless glass only seven seeds had germinated: they were all like fig. 4. The leaves were of a pale green colour, and had not succeeded in bursting the membranous sheath; the roots were very long. Under the obscured yellow glass, the plants were of a greener colour than the preceding; six of them were like fig. 3, excepting that the leaves were very much taller, perhaps 7 inches high. In the dark all the plants were weak, and of a very pale green colour, almost yellow; the radicles had many rootlets branching out from them; four were like fig. 5; two others were smaller and had second leaves, while other two were very short in the leaves.

After this, the plants under the colourless glass continued to grow healthily: the hairs along the roots became very long and thick, and on the 22nd of May, ramifications of the rootlets began to appear. The plants under the blue did not continue so healthy, nor did those under the red. Under the yellow glass, both the upper plant and the roots continued to grow. Under the obscured yellow glass and in the dark, the plants also continued growing. On the 26th, a more full examination and fresh drawings were made. Under the colourless glass there were ten wheat plants like fig. 6, generally 8 or 10 inches in height. Under the blue glass there were several very thin weak plants, only about 2 inches high. Under the red, the utmost development was to the extent of fig. 7, in the case of three plants. The rest that were growing had not succeeded in breaking the membranous sheath, but were contorted in their efforts to escape. Under the yellow, three plants had grown like those under the colourless glass; three others were not so fully developed, while the remaining four had not germinated. Under the obscured colourless glass, the wheat had not grown since May 12th. Under the obscured yellow, I found six plants like fig. 8. In the dark, the plants had grown much as under the obscured yellow glass, but they were still longer, weaker, and paler in colour.

On June 5th, the experiments were stopped. The plants under the colourless glass were healthy in every respect, and were of a better green than any of the others. Under the red glass, one of the plants was found to have shot up several small leaflets outside the transparent sheath, which it had been unable to pierce.

The following table shows the number of seeds of wheat which had put forth roots, and the average length of the principal roots; and also the number of seeds from which plants had grown, together with the average length of the principal leaves.

	Roots.		Leaves.	
	No. of plants.	Length.	No. of plants.	Length.
Colourless	10	2·5 inches	10	10 inches
Blue	6	0·75 "	6	4 "
Red	8	3·5 "	4	4 "
Yellow	7	2 "	6	9 "
Obscured colourless	6	3·5 "	3	2 "
Obscured yellow	6 2	0·75 " 2·5 "	7	8 "
Dark	7	3 "	6	13 "

The plants were removed from the bricks, spread out on the table, and allowed to dry in the air for eighteen hours. The following table shows the weight of those which had grown under each of the various conditions of light. The original weight of the twelve corn-seeds was in each instance 8 grains, giving as the average weight of each seed 0·66 gr.

	No. of plants which had germinated.	Weight.	Average weight of each.	Average increase upon original weight.
Colourless	10	31 grs.	3·1 grs.	2·4 grs.
Blue	6	4 "	0·66 "	0 "
Red	8	4·5 "	0·56 "	−0·1 "
Yellow	7	8 "	1·1 "	0·4 "
Obscured colourless	6	4 "	0·66 "	0 "
Obscured yellow	7	10 "	1·4 "	0·7 "
Dark	7	9 "	1·3 "	0·6 "

The increase in weight of the plants which had grown under the colourless, the dark, and the yellow glasses, was due, of course, to the fixation of water, for there was no supply of carbonic acid from the air, and the quantity of substance which the roots could absorb from the bricks must have been very trifling.

The comparative experiment in which the seeds were exposed to the open air of the room did not come to anything. Not one of the seeds succeeded even in bursting the tunic, doubtless because the dry atmosphere prevented their ever retaining sufficient moisture.

The presence of soil about the germinating seeds, or a constant change of air, would probably have modified these results; yet the conditions observed in this series of experiments were thought necessary, in order to have the full effect of the different sorts of light about the seeds themselves, for a soil necessarily produces partial, if not total obscurity. The deprivation of other sources of carbon, beyond the cotyledons of the seed itself, also answered certain purposes. On examining the results, the following conclusions may be drawn, as far as wheat is concerned growing under the conditions of the experiment. The absence of the chemical rays favours the first growth of rootlets, and the presence of the luminous rays does not impede it. Afterwards the opposite effect takes place; the roots are stopped in their development by the yellow ray much more than by all the rays of the spectrum in combination. The red or calorific ray is on the whole the most favourable to the growth of the roots, even more so than the complete absence of all solar radiations. The shooting forth of the plume is also favoured by the withdrawal of the chemical rays, especially just at first; but the full and healthy development of leaves requires all the rays of the spectrum, the luminous being particularly necessary. Several other peculiarities may be noted; for instance, the downward tendency of the roots under the pure luminous influence; the comparatively greater development and strength of the membranous sheath under the calorific agency; and the late but abundant growth of side-rootlets, where all the solar radiations were admitted.

The results of the experiments on wheat recorded in the previous Report, where there was the presence of soil and change of air, appear to indicate still more clearly the beneficial character of the luminous emanations, for the plants under the yellow shade were found even to excel those which had grown in white light, while, as in the experiment just detailed, the cutting off of the luminous ray by the deep blue glass militated greatly against the health of the plants. The protection of the rootlets from the yellow ray may be fairly considered an advantage, but a proper series of experiments on wheat-seeds surrounded by earth is still a desideratum.

We have now to consider the growth of the *peas* under the different solar influences. It has been already stated that twelve peas soaked in water were placed on the bricks along with the wheat seeds, on April 21st. On the 24th they were found to be swollen and beginning to burst. The seeds under the yellow, obscured yellow, and obscured colourless glasses, were the more rapid in their first development. On the 29th, the plumes began to appear under the obscured colourless, yellow, and red shades, and two days afterwards under the blue and colourless. The plants under the obscured yellow glass appeared very unhealthy. The radicles grew astonishingly under the yellow glass, and became very long under the red and obscured colourless. On May 8th, the plants in complete or partial obscurity were found to be several inches high; under the red, 2 inches; under the yellow, not quite so much; while even on the 11th, the plants under the blue had only just developed themselves, and under the colourless glass only one seed had put forth a stalk, and that was but half an inch in length.

On the 12th they were more fully examined, and drawings were made. Under the colourless glass, the peas resembled fig. 1, Plate V. the plume only in the first stage of development, the principal root short and thick, with short and thick secondary rootlets, all fringed with hairs. Under the blue, the peas were in a somewhat more advanced stage, like fig. 2. Under the red, ten plants had grown somewhat like fig. 3,—roots straggling, stalk bending towards the light, with many leaflets of a deep green colour. The plants under the yellow glass were characterized by enormous roots, as shown in fig. 4, which turned away from the light in a very marked way. Nine of those under the obscured colourless had the appearance presented by fig. 5,—long roots, long succulent weak stalks, and pale green leaflets. Under the obscured yellow, the plants appeared for the most part like fig. 4, but with smaller roots, though two of them, which were nearest the light, had grown with a stalk like that represented in fig. 5. In the dark, six of the peas had grown like fig. 6,—roots irregular, having few side-rootlets, stalks succulent, but tolerably erect, bearing yellow leaflets. The plants in the red light continued to grow healthily, some being 6 inches high on the 15th; under the yellow and obscured yellow, they also grew healthily; under the obscured colourless, the stalks were found on the 22nd no longer capable of supporting themselves. The stalks in the dark were at the same time erect, and 10 inches in length. On the 26th, the seeds under the colourless glass were found to have made scarcely any advance since the 12th. Under the blue, one had grown tall and healthy, but the rest were very small. Under the red, the plants were growing healthily as on the 12th, but some of them had attained the height of 9 inches, and bore three or four secondary branches. Those under the yellow had grown, but did not appear healthy. Under the obscured colourless glass, the plants had grown since the 12th about as much as might have been expected from the time, but they were very weak. Under the obscured yellow glass there were two very similar to, and nearly as large as, those under the obscured colourless. Six others were of the same character, but much smaller; the roots were very short. The plants in the dark had also grown since the 12th.

On June 5th the experiments were discontinued. The longest pea-plant under the colourless glass was then only 1·75 inch in length; the secondary rootlets were remarkably short and thick. The plants under the blue appeared the most healthy; those under the yellow, whether in full light or obscured, showed considerable inclination to send out lateral branches. The stems of the plants in the dark were white, the leaflets were canary-yellow; those which had grown in partial obscurity were also much etiolated. One of the peas under the obscured yellow had produced a triple stem, and so had one of those under the obscured colourless glass, as drawn in fig. 7.

The average length of the roots and stalks of those peas which had germinated under the different solar influences is given in the annexed table:—

	Tap roots.		Stalks.	
	No. of plants.	Length.	No. of plants.	Length.
Colourless	10	1 inch	10	1 inch
Blue	10 2	2 " 5 "	12	7 "
Red	11	3·5 "	11	6 "
Yellow	7 4	1·5 " 6·5 "	10	6·5 "
Obscured colourless	10	2 * "	9	6 "
Obscured yellow	10	1·5 "	10	5 "
Dark	12	3 * "	12	14·5 "

The plants were removed from the bricks and allowed to dry in the air for eighteen hours. The following table shows the increase of weight which had taken place in them during their growth:—

	Original weight of 12 peas.	No. of plants which had germinated.	Weight.	Average weights of each.	Average increase of original weight.
Colourless	33 grs.	10	54 grs.	5·4 grs.	2·7 grs.
Blue	34·5 "	12	73 "	6·1 "	3·2 "
Red	30 "	11	47 "	4·3 "	1·8 "
Yellow	34 "	11	72 "	6·5 "	3·7 "
Obscured colourless	35·5 "	10	83 "	8·3 "	5·4 "
Obscured yellow	31·5 "	10	85 "	8·5 "	5·9 "
Dark	31·5 "	12	150 "	12·5 "	9·9 "

* Very various.

It being thought that the disproportionate weight of the plants which had grown in the dark might be partially owing to their not having become thoroughly air-dried in eighteen hours, on account of their succulent character, they were exposed in the same manner for forty-eight hours. Their weight was then reduced to 66 grains, whilst those grown under the obscured colourless (succulent as they were) lost in the same time only 14 grains; and those under the obscured yellow appeared rather to have gained weight.

The increase in weight in these instances must be attributed, as in the case of the wheat, to the absorption of water, and it seems to be in almost reverse ratio to the healthiness of the plant; for those under the red, which had the best appearance at first, showed by far the smallest increase in weight; and those under the blue, which were afterwards better looking, had not increased greatly.

In the comparative experiment made without any glass shade, one pea began to germinate on May 23rd; this was shortly followed by two others, but only one of the three grew to any size. When measured on June 6th, its root was found to be only 0·75 inch long; its stalk had attained a length of 4·5 inches; its leaflets were deep green, appearing as healthy as, if not healthier than, any under the glass shades, and when removed from all moisture for eighteen hours, it weighed 5·5 grains, showing an increase of 2·7 grains on its original weight.

On examining these results we are led to draw the following conclusions, as far as peas are concerned, growing under the conditions of the experiment. The cutting off of the chemical rays favours the first germination of the seed, and this appears to be the principal, if not the only advantage of the darkness obtained by burying the seeds in the soil. The development of roots also requires the absence of the chemical ray, yet it does not go on to the greatest extent when all the solar influences are excluded, but is favoured rather than otherwise by heat and luminosity. The first development of the plume also proceeds best under the same circumstances; yet these are not the conditions which produce a healthy plant: if all the solar radiations be withdrawn, whether entirely or only to a great extent, the plants absorb much water and grow very tall, without developing secondary branches or many leaves. The whole force of these radiations, on the contrary, prevents or greatly impedes the growth of these plants under the circumstances of the experiment. As peas grow commonly in the full sunshine, it would be interesting to observe whether the negative result obtained arose from the absence of soil about the roots, from excessive moisture, or from some other cause. The experiment, however, affords us no data for determining this question. The chemical force is the most antagonistic to the growth of the pea, and luminosity also militates against it: the heating rays are favourable; but let the plant be fairly established, and those radiations which are comparatively speaking devoid of light, but replete with chemical power, are the most suited to the production of a healthy growth. The influences which facilitate rapid growth are diametrically opposed to healthy development. It should be borne in mind, however, that these observations relate only to a very early stage of the plant, and teach us nothing respecting the full-grown pea, or the evolution of the flower or fructification.

If we compare the effect of the various solar radiations upon the germination of wheat with the effect produced upon that of peas, we are struck with the great diversity between them. This was particularly apparent during the progress of the experiment. The colourless and the red glasses happened to stand side by side on the table, and it was curious to notice under the former glass a tall and vigorous crop of corn-plants with a mere matting of stunted roots from the peas, while under the other a thick crop of green spreading plants arose from the germinating peas, but the wheat-plants were few, straggling, and unhealthy in appearance. When, however, we come to look more closely into the phænomena, we see certain points of resemblance. In both cases the cutting off of the chemical ray facilitates in a marked manner the process of germination, and that both in reference to the protrusion of the radicles and the evolution of the plume. The unnaturally tall growth of the stem, and the poor development of leaves in darkness, more or less complete, is also common to both these specimens of the monocotyledonous and dicotyledonous plant. In both cases too, the yellow ray exerted a repellent influence upon the roots, giving the wheat a downward and the pea roots a lateral impulse.

The object of employing a partially obscured yellow glass in these experiments, was to decide if possible the question which has been asked, Does yellow light stop germination by some specific action or merely by the excess of light? Contrary to the experience of some others, who, I believe, have experimented on seeds covered with soil, and on other plants than those employed by me, the yellow light did not interfere at all with germination, in the experiments just described. In the case of both plants, indeed, it decidedly facilitated the early development of both the root and the plume. That the yellow ray, however, has a specific action of its own, is proved by the most cursory glance at the facts already recorded; the yellow and the obscured yellow give quite different results from those of any of the other glasses.

The diversity between the effect of the same qualities of light upon the growth of the wheat and the pea leads us to suspect at once any generalisations affecting other plants which may be drawn from the observed influence of light upon one particular plant, especially, of course, when they are of different orders. This will account for some of the diversity of statement made by previous experimenters in these fields.

The subject may be, however, further elucidated by referring to some of these. Dr. Draper, in his elaborate investigation of the forces which exert a controling influence on the growth of plants, records a series of experiments on peas. He placed them just after they had begun to grow in blue, red, and yellow light, and also in the dark, and in the open air. His observations were confined to the third and fourteenth days. At the former period he found that under the red the plant had attained 4·5 times its original size, and had produced double the number of leaves; under the blue, three times its original height, with also double the number of leaves. In the dark there was about the same increase of altitude, while in the open air only twice the original height had been attained, and there were no fresh leaves; and under the yellow light, a still smaller advance had been made. On the fourteenth day he found all his pea-plants green, though varying a little in the character of the colour, except those which had been placed in the dark, which were of a pale whitish yellow, the plants vigorous, thirteen times their original height, but with no fresh leaves. On the whole, then, as far as Dr. Draper's experiment goes, it is in accordance with my results.

M. Senebier describes an experiment performed by him on lettuce-seeds sown in little cups and placed respectively in the open air in full light of day, in darkness, and under glass vessels filled with colourless, yellow, red, and violet fluids. "Observing then the effects produced by the different portions of light which were thus permitted to act, he found that the plants illuminated by the yellow rays grew most rapidly in height; next, those in the violet rays; afterwards those in the red rays. The plants which grew in light transmitted through water were still smaller and approached in size to those which flourished in the open air, while those in perfect darkness attained the greatest height of all. These last plants perished on the eighth day, and those in the yellow light on the ninth day, while all the others continued to vegetate. At the end of about five weeks, the plants growing under the red vessel were 4 inches and 9 lines in height; under the violet vessel 3 inches and 3 lines; under the water vessel 2 inches and 10 lines, and 1 inch and 3 lines in the open air. With respect to the general appearance of the plants, the leaves of those which grew in red light were smaller and less smooth than those of the plants in violet light, or than the leaves of the plants confined under water, or than the leaves of those which grew in the open air. As to colour, the leaves exposed to yellow light were at first green and afterwards became yellow; those in red light appeared green and preserved a tinge of that colour; those in violet light were quite green and their colour augmented with their age; while those raised in obscurity possessed no verdure at all." These experiments were repeated on French beans with nearly similar results, but beyond the observation that "in proportion as the plants grew in height, in different kinds of light, the number and size of their leaves diminished," his attention appears to have been directed only to the question of colour*.

Besides the experiments already detailed in this Report, and those on wheat and *Malope trifida* described in my former one, I have a few other observations on the effect of various qualities of light on the growth of plants from the seed, which it may be worth while briefly to record. They were made on the *Collinsia bicolor* of the florists, and *Mignonette*.

Seeds of the *Collinsia* were sown in garden mould in glasses, and placed under the colourless, blue, yellow, red, and darkened shades, on a table before a window which had a N.W. aspect. The perforated boards were used for supporting the glass covers. The experiment was commenced on the 6th of July in last year. On the 9th it was found that germination had taken place under each glass except the yellow, where no plant grew until the 14th. Under the colourless glass, the plants grew and flourished till the beginning of August, when they all faded and died. Under the blue and red glasses they grew well for awhile, but began to droop by the 26th of July. Those under the darkened glass existed rather longer, but they were tall and scraggy, and the leaves did not fairly open. Only three plants germinated under the yellow shade; they were all unhealthy and died before the 26th. On August 4th, seeds were sown afresh under each glass. Much the same order of growth was observed.

On October 12th, a hundred seeds of Mignonette were sown in each of seven glasses filled with garden mould. They were placed about a third of an inch below the surface. Six of the glasses were covered respectively with the colourless, blue, red, yellow, obscured colourless, and obscured yellow shades, and the seventh was placed in a dark closet. It should be observed that the closet was rather warmer than the room. The Mignonette seeds began first to germinate in the dark, then under the blue; then, after the lapse of a few days, they appeared under the red, and colourless, and the obscured colourless glasses. The yellow ray long retarded, and very nearly prevented their germination. Those in the dark were tall, thin, and yellow; they all died about November 1st; the others soon followed, excepting one plant under the colourless glass, which was found still alive with four green leaves on December 10th.

The investigations of many experimenters have shown that oxygen is necessary in the germination of seeds. The explanation given is that that element is required for instituting the action that converts the fecula of the cotyledon into sugar. It is unquestionable, that in the majority of cases, plants after the first stage of their growth require a certain supply of carbonic acid, by the decomposition of which they obtain carbon, setting free oxygen. My brother and I have shown that plants will exist well for a considerable time in an atmosphere devoid of oxygen, for instance in nitrogen, hydrogen, coal-gas, or carbonic oxide. In order to see the effects of all these atmospheric conditions on the germination of wheat and peas, the following experiments were made during the latter part of May and the beginning of June.

---

* From Ellis's "Farther Inquiries," &c.

Six wheat-seeds and six peas were placed on folds of linen floating on mercury, and covered with a colourless glass jar having a capacity of about 20 cubic inches. The linen preserved the seeds from the mercury, and was kept wet by the introduction of a small quantity of water. The jar was full of atmospheric air, and was placed on the table before the window having a S.E. aspect. After a couple of days or so the peas germinated, and shortly afterwards the wheat. They grew for about a week, and retained a healthy appearance much longer. The experiment was twice performed with similar results, and showed that the arrangement was applicable to the proposed experiments.

A precisely similar arrangement was made in a jar containing 29 cubic inches of hydrogen gas, and having in it a tube containing pyrogallate of potash, so as to absorb any trace of oxygen which might be accidentally present in the gas, or might be evolved from the seeds themselves. In four days the swollen peas had begun to burst. They put forth short radicles, but no plume, and in about a week afterwards they were all decaying. The wheat showed no appearance whatever of germination. This experiment was twice performed with the same result.

Another such arrangement was made in a jar filled with carbonic acid. Not the slightest appearance was indicated by either the wheat or the peas. They decayed, becoming soft and swollen, and emitted a most offensive smell on the removal of the jar.

The same was done in a jar filled with common air, and containing a solution of caustic potash in a small capsule, so as to remove any carbonic acid which might be given off by the seeds. In about three days both the wheat and the peas had begun to burst; four out of the six of each continued to grow for about six days, and remained healthy afterwards. The removal of the carbonic acid, then, did not affect the germination. I subsequently found that in this experiment I had almost exactly repeated one of Mr. Ellis's in his 'Inquiry into the changes produced on atmospheric air by the germination of seeds,' &c. He employed peas, and satisfied himself that all the oxygen in the jar had been absorbed by the germinating plants.

The effect of oxygen on the germination of wheat and peas under the influence of the different solar radiations was also tried. The small coloured glasses, having a capacity of 172 to 177 cubic inches, were employed, and the experiments were conducted like those under the coloured shades which have been already detailed. The seeds were placed on the bricks on May 2nd. On the 8th, both the wheat and the peas had burst under the colourless glass, but they soon became mouldy, and before the end of the month they were quite dead. The seeds under the yellow glass ran much the same course; but those under the blue glass, though they did not burst till the 11th, grew well, and by the 26th two of the wheat plants had attained a height of 4 or 5 inches. The experiment was discontinued on June 5th. The plants were removed from the brick for desiccation, and on the following day the five of the wheat which had germinated were found to weigh 8 grains, giving an average of 1·6 grain for each, or an increase of 0·9 grain on the original weight. All the six pèas had germinated and weighed 26 grains, giving an average of 4·3 grs. for each, or an increase of 1·6 grain on the original weight.

Thus far I have proceeded in the investigation. Many interesting inquiries naturally suggest themselves; some have been already alluded to, for instance, the influence of light upon the colours of flowers; the amount of exclusion of light effected by the soil; the different condition of solar influences required by wheat or by peas at later periods of their growth; and the extension of the observations to other seeds. Other questions might be raised, such as,—What character of light promotes best the absorption of oxygen in germination? At what period in the growth of a plant does oxygen become unnecessary? Is oxygen requisite for the full development of a bulbous-rooted plant? Does carbonic acid act specifically in the prevention of germination, or merely by the exclusion of oxygen? How far does the rapid development of a plant in an early stage interfere with its healthy growth at a later period?

Report on Observations of Luminous Meteors, 1853–54. *By the* Rev. BADEN POWELL, *M.A., V.P.R.S. &c., Savilian Professor of Geometry in the University of Oxford.*

I HAVE once more to lay before the Association a series of such observations on luminous meteors during the past year, as the kindness of various friends, to whom I have been indebted on former occasions, has enabled me to collect, together with a few notices from other sources. I need hardly particularize the valuable assistance rendered by the Rev. J. B. Reade, V. Fasel, Esq., C. Bulard, Esq., and E. J. Lowe, Esq. The beautiful projections of the paths of many meteors by Mr. Fasel are remarkable for the clearness and accuracy of their execution.

I deeply regret that the pressure of various avocations has still hindered me from prosecuting an attempt at classification of the large mass of materials now accumulated in the catalogue of seven years; but I hope at no distant period to be able to effect something towards such a work; and am most anxious to secure the cooperation of the members of the Association and other friends to science in this work.

Supplement to the Report of 1852–3. *On the August Meteors,* 1853.

In addition to the observations recorded in the last Report, by which the return of this periodical phenomenon seems to have been well shown in England, the following details of continental observations are now given, of which the compiler was not in possession till too late to be inserted in the Report of last year.

No. 1.—Poggendorff's Annalen, 1853, No. 9, p. 192.

Coulvier Gravier gives the hourly maximum of meteors from the 9th to the 10th of August, for different years, as follows at Paris:—

1837	59	1841	71
1838	62	1842	74
1839	65	1843	78
1840	68	1844	80

1845	85	1850	83
1846	92	1851	71
1847	102	1852	60
1848	113	1853	52
1849	98		

Which is thus rapidly declining since 1848.

No. 2.—M. George von Boguslawski. Poggendorff's Annalen, 1853, No. 10, p. 338,

Maintains the continuance of the August meteor period in opposition to Coulvier Gravier who contends that that maximum has been decreasing since 1848, and that in 1860 it will at the same rate cease to appear altogether. But his observations were always made at midnight, which M. Boguslawski observes cannot give a fair average.

Again, these periodic appearances are characterized by having a definite origin in the heavens. M. Heis has observed three such points; on Aug. 10, 1852, he observed out of 32 meteors, 14 originated from Perseus, 8 from Draco, 6 from the North Pole, and 4 Sporadic.

1853, Aug. 9.—From 10 P.M. to 2 A.M. though the sky was partly clouded yet 20 were seen, of which 12 originated in Perseus. The phenomenon was seen at Aachen (Aix), Ghent, Munster, Bonn, Brussels, Oxford, Newhaven, U.S., and many other places.

There is no particular hour at which the maximum takes place. In 1837 Aug. 10, the hour of maximum was different at different places, the sky being perfectly clear both in Europe and in the United States. At Paris it took place from 11 to 12; at Breslau from 1 to 2 A.M.; at Mailand from 2 to 3.

In 1838, Aug. 9 and 10 in the United States from 3 to 4 A.M.

1839, Aug. 10 { at Breslau from 1 to 2.
at Frankfort from 12 to 1.
1841, Aug. 10, Aix 9 to 10.
1842, Aug. 9, Aix 10 to 11.
" " 10, " 11 to 12.
" " 11, " 12 to 1.
1844, Aug. 10, " 10 to 11.
1847, Aug. 11, " 12 to 1.

Boguslawski also denies Coulvier Gravier's assertion that from July 26 to August 11, the rise towards the maximum is continuous; as he shows even from Coulvier Gravier's own observations, that there is a marked interruption of continuity and sudden rise between the 8th and 9th of August.

He contends that the maximum is very unequal in different years, owing to the varying influences of unknown cosmical causes.

He refers to Humboldt's refutation of Coulvier Gravier's views as to the failure of the November period in 'Comptes Rendus,' No. 29, p. 601.

He also urges that the evidence for the August period rests on long-continued historical evidence for ages past; it is, therefore, improbable it should now cease.

No. 3.—M. Quetelet on the August Meteors 1853.

In the Bulletins of the Academy of Brussels (vol. xx. No. 9) there occurs a valuable paper entitled:—" On the periodic falling stars of the 9th and 10th of August, 1853, by M. A. Quetelet," of which the following is a translation:—

The periodic return of falling stars has been again verified this year. On the evening of the 9th one of my assistants, M. Bouvy, counted by himself 57 meteors between half-past nine and midnight, divided as follows:—

From 9½ to 10, 6 falling stars.
From 10 to 11, 23 ditto.
From 11 to 12, 28 ditto.

The state of the sky was very favourable, excepting during the first half-hour, the moon being then still above the horizon; from 10 o'clock until midnight one single observer obtained on an average 25·5 falling stars an hour.

On the evening of the 10th a larger number of persons joined in the observations: two Egyptian Astronomers, M.M. Mahmoud and Ismaïl, joined me and my two assistants, MM. Bouvy and Grégoire; the latter was almost exclusively occupied in transcribing the observations. Many falling stars were seen at once by several amongst us, because that part of the heavens which is visible from the Observatory terrace, only includes two-thirds of the sky; the N.W. and N.E. regions are hidden by buildings, and one part of the E. by trees; so that two observers would fully suffice to note all the appearances. They occurred thus:—

From 9½ to 10, 34 falling stars.
From 10 to 11, 77 ditto.
From 11 to 11½, 18 ditto.
From 11¼ to 12, 34 ditto.

The sky continued perfectly clear the whole evening; but until 10 o'clock, the presence of the moon would necessarily diminish the number of the meteors. From 11¼ to 12 o'clock, there was but one observer; therefore, by doubling the number (34) counted by him, and only including the observations made after the setting of the moon, we obtain a mean of 82·5 meteors an hour for two or more observers.

Just as in preceding years, it seems that the number of meteors decreases progressively from the 10th August, thus—

The 6th, from 9·15 to 11·45, with a clear sky, M. Grégoire counted 15 meteors, making 10 an hour, rather more than the ordinary average.

The 8th, from 9 to 12 o'clock, M. Dutilleul counted 39, although the sky was generally cloudy, particularly from 9 to 10 o'clock: he observed on an average about one-third of the sky; being 13 meteors an hour.

The 9th, as seen above, produced 25·5 an hour; whilst on the 10th, one single observer would have been able to count about 41.

The 11th, M. Dutilleul, observing alone from 9 o'clock till 12, with a clear sky, yet counted 55 meteors, making 18·3 an hour.

The observations made on the 12th, from 9¾ to 10¾, did not enable M. Bouvy to count more than 15 in an hour, with a clear sky; and the day after (13th), the number observed by M. Grégoire was under 8, the ordinary average.

Now, if we group the falling stars according to their brightness, we obtain the following numbers:—

Aug. 9.	Aug. 10.	
15	52	of the 1st mag. and larger.
16	24	of the 2nd.
10	33	of the 3rd.
8	13	of the 4th.
18	16	of the 5th and smaller.
0	25	undetermined.

About one-third of them left trains, 22 on the evening of the 9th, and 119 on that of the 10th August. Two meteors on the 9th deserve particularly to be mentioned; the first crossed Lyra from the N.E. to the S.W. at $10^h\ 46^m$; it shone like Jupiter, and left a superb train after it. The second, larger than a star of the first magnitude, appeared at $11^h\ 45^m\ 45^s$ in Cassiopeia, going from N.N.E. to S.S.W.; it was remarkable for the bluish-green shade of its train, which lasted for some seconds.

Two others were equally remarkable for their brilliancy on the evening of the 10th; one, with a reddish train, crossed Andromeda from the S.W. to the N.E., at $10^h\ 57^m$; the other marked its passage across Aquila, from the N.E. to the S.W., at $11^h\ 50^m\ 30^s$, by a trace subtending an arc of more than 45°.

If we study the general movements of the falling stars from the 8th to the 12th August, we remark the same tendency as formerly to follow a uniform direction from the N.E. to the S.W. Referring their trajectories to parallel lines passing through the zenith, we have as follows:—

Directions.	Aug. 8.	Aug. 9.	Aug. 10.	Aug. 11.	Aug. 12.	Total.
From N. to S.	5	4	20	16	1	46
„ N.N.E. — S.S.W.	....	10	17	....	1	28
„ N.E. — S.W.	13	20	53	3	5	94
„ E.N.E. — W.S.W.	2	1	19	2	1	25
„ E. — W.	4	1	18	7	1	31
„ E.S.E. — W.N.W.	....	1	1	....	....	2
„ S.E. — N.W.	3	1	6	1	....	11
„ S.S.E. — N.N.W.	....	....	2	2	....	4
„ S. — N.	4	....	6	1	....	11
„ S.S.W. — N.N.E.	2	3	....	8	....	13
„ S.W. — N.E.	1	1	2	7	1	12
„ W.S.W. — E.N.E.	1	....	1	1	....	3
„ W. — E.	2	3	3	2	1	11
„ W.N.W. — E.S.E.	1	1	6	....	....	8
„ N.W. — S.E.	....	8	9	....	1	18
„ N.N.W. — S.S.E.	1	3	....	....	1	5
Total	39	57	163	40	13	323

In short, if we prolong the paths of these falling stars beyond their point of departure, we count about two-thirds of these on the first evening, and three-fourths on the second, whose centre of emanation was from the neighbourhood of Cassiopeia.

Observations made elsewhere confirm this remarkable appearance of falling stars, on the 9th and 10th August of this year.

The following accounts have been communicated to us from Ghent, Rome and New Haven:—

GHENT.—*Letter from M. Duprez, of the 12th August,* 1853:—"On the nights of the 9th and 10th August, and in a completely clear part of the sky, comprised between the N.N.E. and the S.E., which might be about equal to one-sixth, I observed 29 meteors during the first evening, and 37 during the second; they were distributed as follows:—

	Aug. 9th.	Aug. 10th.
From $9^h 50^m$ to 10	3	2
From 10 to 11	12	15
From 11 to 12	14	20

which gives, on an average, 13·3 meteors an hour on the 9th, and 17 on the 10th; larger numbers than 8, which, according to your estimate, may be regarded as the average for an ordinary night, with a single observer.

"Amongst the meteors observed on the 9th was one, the appearance of which was accompanied by circumstances which I think should be mentioned here.

"This meteor appeared at $10^h 35^m$, near the head of the Great Bear; it presented the aspect of a globe of fire, left no train after it, and could, from its brilliancy and dimensions, be compared with Jupiter: besides this, it moved with considerable slowness. In the course of its continuation, the brightness diminished, until it disappeared for an instant, as if completely hidden by a species of whitish smoke, which proceeded from it at this moment; after which it reappeared with its primitive brilliancy. One would have said that the meteor in question was undergoing absolute combustion.

"The meteors observed took the following directions:—

	Aug. 9th.	Aug. 10th.
From N. to S.	3 meteors.	1 meteor.
„ N.N.E. — S.S.W.	....	1 „
„ N.E. — S.W.	9 „	14 „
„ E.N.E. — W.S.W. ..	....	2 „
„ E. — W.	3 „	3 „
„ S.E. — N.W.	2 „	4 „
„ S.S.E. — N.N.W. ..	3 „	4 „
„ S. — N.	....	2 „
„ S.W. — N.E.	2 „	1 „
„ W. — E.	2 „	1 „
„ W.N.W. — E.S.E.	....	1 „
„ N.W. — S.E.	3 „	2 „
„ N.N.W. — S.S.E.	2 „	1 „

"We see that for these two nights the predominant direction was from the N.E. to the S.W. I turned my attention to the existence of a centre of divergence, and just as in previous appearances, the centre is found between Perseus and Cassiopeia; for, of the 66 meteors observed in all, 55 appeared to me clearly to diverge from a point between these two constellations."

New Haven (Connecticut, United States). Letter from Mr. E. C. Herrick, of the 18th August, 1853 ......:—"My time being limited, I shall confine myself here to giving you a report of the shooting stars observed the 10th August, 1853.

"The night of Tuesday, 9th August, was so cloudy that all observation was prevented.

"The night of Wednesday, 10th August, was clear and calm, and the moon set before midnight. The observers were Messrs. Bradley, Lyman, Baird and I. We were in the open air, each observer having to look after, as much as possible, one-third of the visible sky. We commenced regular observations at midnight precisely, and we continued until break of day, at $3^h\ 25^m$. The following table shows the number of shooting stars observed per hour in each third of the sky. That part of the heavens from which they darted is mentioned.

Hour.	S.	N.N.W.	E.N.E.	Total.
0 to 1 o'clock in the morning ..	48	27	35	110
1 to 2 „ „	42	34	39	115
2 to 3 „ „	57	31	31	119
3 to 3 25′ „ „	26	7	11	44

"Besides the 388 meteors mentioned here, we saw about 20 more during the quarter of an hour preceding midnight; we rejected 15 or 20 doubtful cases, and some escaped us after 3 o'clock, either from the morning's dawn, or from other causes. No one meteor was written down twice, although several were seen at one time by two or three observers.

"It must be remarked that the great majority of these falling stars, not less probably than three quarters, moved in trajectories, intersecting very near the group of stars which form the point of the sword of Perseus; and during our observations, the apparent point of emanation did not change its position relatively to the stars. Many of the meteors left trains, and surpassed in brilliancy stars of the first magnitude, whilst some were as brilliant as the planet Venus.

"Towards $2^h\ 15^m$, we saw a luminosity unusual, but yet pale, along the horizon in the N.E. This light increased in proportion as the morning advanced, and was recognised as being the zodiacal light. Its outline was completely undefined, and from the atmosphere being slightly hazy in that region, it was impossible to describe the phenomenon exactly. It extended from the horizon to the N.E., covering the stars Castor and Pollux, and reaching up to the top and in front of the neighbourhood of θ Aurigæ and β Tauri; but no certain trace of light was perceptible south of the ecliptic.

"It is interesting to mention (although I do not pretend that there is any connection between these two phenomena), that there were faint manifestations of the Aurora Borealis, on the 11th, towards 2 o'clock, and again towards 3 o'clock in the morning, during about 15 minutes each time. The light did not rise higher than from 2° to 5° above the horizon, and entirely towards the west of the northern point.

"You see from the above, that the meteoric appearance of August has continued to manifest itself here this year, but that it is somewhat less. The numbers which you observed in August 1852, were, without doubt, less than there would have been, had you observed at later hours of the night."

Rome. Extract from the Corrispondenza Scientifica di Roma, de M. E. Fabri-Scarpillini.—"The observations made by the astronomers of the Roman College, commenced the 28th July, and lasted each evening during one half-hour, between 9 and 10 o'clock: up to the 6th August the number of stars was not more than 3.

"The 6th and the 8th August, they counted 6.

"The 9th, from $9^h\ 24^m$ to $11^h\ 11^m$, two observers counted 37. The following morning, from $2^h\ 45^m$ to $3^h\ 15^m$, one single observer saw 9.

"The 10th, the sky was covered with light clouds until $10^h\ 15^m$; and from $8^h\ 55^m$ to $11^h\ 46^m$, two observers counted 67 falling stars. Between $3^h\ 3^m$ and $3^h\ 45^m$ in the morning, they noted 4.

"The 11th, from $10^h\ 6^m$ to $10^h\ 53^m$, they counted 19; but already the light of the moon prevented their seeing many.

"Most part of the consecutive groups had generally such directions that their trajectories cut through the constellations Andromeda, Cassiopeia and Perseus, but more especially the two latter."

In one of the late numbers of the Institute, M. Coulvier Gravier gave his opinion that the meteoric appearance of August has a tendency to lessen from year to year. We have thought that it would be interesting to verify this assertion, by the observations made since 1837, and which have been communicated to our Academy.

We have calculated, in the following table, the average number of meteors observed in an hour at Brussels, at Ghent, and at Parma. At Brussels and at Parma, the observations have been made each year, under nearly identical conditions and in the same parts of the heavens; we have only comprised in these means, those hours when the sky was clear, taking care to double the numbers of observations during the intervals when there was but one observer. At Ghent also the numbers are perfectly comparable among themselves, having been obtained each year by M. Duprez, who explored always the same part of the sky that is comprised between the N.E. and the S.E. These numbers, obtained by one single observer, have been doubled in the table to render them fit for comparison with those of other stations, conformably to the principle which we laid down†, *that several observers placed so as to see the different parts of the sky would count a double number*. The numbers thus doubled are marked with an asterisk.

Years.	Mean number of Meteors per hour from the 8th to the 12th of August.											
	Brussels.					Ghent.			Parma.			Paris.
	8th.	9th.	10th.	11th.	12th.	9th.	10th.	11th.	9th.	10th.	11th.	10th.
1838	......	......	30·2	27·2	......	......	......	......	16·7	29·7	......	62
1839	......	34·2	66·2	......	......	40·0*	88·0*	......	52·9	121·3	......	65
1840	......	......	......	......	......	43·2*	......	......	51·6	49·8	......	68
1841	......	17·0	44·0*	......	......	38·6*	40·0*	......	14·5	41·1	18·6	72
1842	......	49·2	112·4	55·0	......	41·2*	125·2*	......	38·8	72·6	......	74
1843	......	......	......	22·0	......	......	......	......	......	......	......	78
1844	......	......	......	......	......	......	......	......	......	......	......	80
1845	58·0*	51·7	......	......	......	......	......	......	......	......	......	85
1846	......	......	ordin.	......	......	......	20·0*	......	......	ordin.	......	92
1847	......	30·0*	......	30·0	......	24·0*	......	44·0*	......	......	......	102
1848	......	......	......	......	......	18·0*	......	......	......	......	......	113
1849	......	......	28·0	......	......	54·0*	50·8*	......	73·2*	......	......	98
1850	......	39·3	74·0	......	......	......	......	......	......	......	......	83
1851	......	......	......	......	......	......	......	......	......	......	......	71
1852	......	......	56·5	36·0*	23·2*	18·0*	55·4*	......	......	......	......	60
1853	26·0*	51·0*	82·5	36·6*	30·0*	26·6*	34·0*	......	......	......	......	52

---

† Bulletin, vol. *iii*. p. 411.

In the following table, we have united the results obtained in a great number of other stations, but for different years.

Years.	Mean number of Meteors from the 8th to the 12th of August.					Stations.
	8th.	9th.	10th.	11th.	12th.	
1837	......	......	51·4	......	......	Bremen.
1837	......	......	79·7	......	......	Breslau.
1838	......	......	......	53·0	......	Geneva.
1839	......	......	63·3	......	......	Geneva.
1839	......	......	45·0	......	......	Paris Observatory.
1839	......	28·3	......	......	......	Berne.
1840	......	......	52·0*	......	......	Collingwood, Kent.
1840	......	148·7	......	......	......	New Haven, United States.
1841	......	37·0	63·0	......	......	Guastalla, Burmese States.
1842	77·4	67·5	107·0	......	......	New Haven.
1842	......	72·9	130·5	......	......	Breslau.
1842	......	......	129·0	......	......	Vienna.
1842	......	......	81·0	......	......	Paris Observatory.
1842	......	......	117·0	......	......	Tours.
1842	......	......	184·0	......	......	Maiche (departm. of Doubs).
1842	......	50·0*	......	......	......	Bruges.
1845	......	64·0	......	......	......	New Haven.
1846	......	......	27·6*	......	......	Dijon.
1847	......	......	48·0*	111·3	66·7	Aix-la-Chapelle.
1849	......	82·0*	......	......	......	Neustadt, near Vienna.
1849	......	......	50·8	38·0	......	Aix-la-Chapelle.
1850	......	......	44·2	34·4	......	Aix-la-Chapelle.
1850	......	......	120·0*	80·0*	......	Dijon.
1850	......	......	117 0	......	......	Markree, Ireland.
1850	......	......	56·7	......	......	Rome.
1850	......	80·0*	63·2	52·0*	32.0*	Naples.
1853	......	......	119·1	......	......	New Haven.
1853	......	24·4	20·3	24·2	......	Rome.

The numbers given in these two tables, excepting those furnished for M. Coulvier Gravier for Paris, continue rather irregular, and though they seem to decrease during the period from 1843 to 1848, they appear on the contrary to increase during the two or three later years. These results appear to us moreover too uncertain to deduce positive conclusions therefrom, yet it seems to us that they are sufficient to render the assertion of M. Coulvier Gravier doubtful.

In the table which he gives, the night of the 10th of August 1842 is only marked by 74 falling stars, whilst many more were counted in Paris itself† and generally in all other localities.

It would, moreover, be well to know what allowance this scientific man, who observes these phenomena with so much perseverance, has made for the greater or less presence of clouds during the observations, and the influence of the lunar light towards the epochs; it would also be well to know whether he has explored the same parts of the sky and with the same observers; it would be necessary in short to have the results perfectly in a condition to be comparable with each other.

We find no gaps in the numbers of M. Coulvier Gravier; notwithstanding that during some of the years, and especially in 1844 and 1851, the observation of falling stars was almost entirely impossible. It is to be regretted that we have not had an opportunity of seeing the whole of his work, in order to form a right idea of the manner in which he has filled up these gaps.

† See the Comptes Rendus, vol. xv. no. 9, p. 452.

A Catalogue of Observations of Luminous Meteors, made at the Observatory, Ston

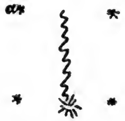
Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or duration.
1853.	h m s				
Sept. 6	7 34 49 p.m.	1st mag.	Colour of Jupiter.	No train	Rapid
	9 9 10 p.m.	3rd mag.	White	Train	Rapid
	9 26 39 p.m.	4th mag.	Blue		Rapid
	9 30 4 p.m.	1st mag.	Orange	Train	Rapid
	9 47 54 p.m.	2nd mag.	Orange	Train	Rapid
	9 50 19 p.m.	3rd mag.	White		Slow
	9 54 39 p.m.	3rd mag.	Whitish		Rapid
	10 50 2 p.m.	1st mag.	As bright as α Lyræ and white.	Train	Slow
	10 55 3 p.m.	2nd mag.	Yellow	Train slightly beaded	Moderate
	11 11 5 p.m.	1st mag.	Orange-red	Beaded train	Moderate
	11 14 22 p.m.	3rd mag.	Blue		Rapid
	11 29 16 p.m.	3rd mag.	Blue	Train	Rapid
	11 29 51 p.m.	3rd mag.	Blue		Rapid
	11 38 46 p.m.	3rd mag.	Yellow	Train	Moderate
	11 47 6 p.m.	4th mag.	White	Train	Rapid
	11 49 55 p.m.	2nd mag.	Orange	Train	Moderate
	12 10 10	2nd mag.	Red	Train	Rapid
	12 22 25	3rd mag.	Yellow	Train	Moderate
	12 24 35	4th mag.	Blue		Rapid
	12 31 34	1st mag.	Blue	Bright light blue-beaded train, with a swell in the middle; the diameter of the centre of this luminous train was about 10′.	Slow

Vicarage, Aylesbury, Bucks. Latitude 51° 47′ 57″·03 N. Longitude 0° 52′ 16″·35 W.

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
From between ζ and η Serpentis, and went a few degrees from N. to S.	If the ☽ had been away, and if had been dark, it would have been of the size and colour of Jupiter.	Stone	Rev. J. B. Reade.	
From ι Cassiopeiæ to Polaris		Ibid	F. Vnt. Fasel, Esq.	
From about χ Andromedæ, and went towards Lacerta.		Ibid	Id.	
From 14 Delphini to α Aquilæ.		Ibid	Id.	
From 6° N.E. of γ Persei, and went about 11° due N.		Ibid	Id.	
From between Algol and δ Persei, and went a few degrees towards Capella.		Ibid	Id.	
From β Aquarii to ϑ Antinoi		Ibid	T. Smith, Esq.	
From γ Lyræ, passed E. of α and went to the mouth of the Dragon, i. e. to μ Draconis.		Ibid	Vnt. Fasel, Esq., and Rev. J. B. Reade.	
From 3° N. of λ Persei, passed d Lyncis, and vanished near 21 Lyncis.		Ibid	Rev. J. B. Reade.	
From 21 Lyncis, passed through 39 Urs. Maj. and vanished 3° beyond it.		Ibid	Id. and F. Vnt. Fasel, Esq.	
From α to γ Urs. Maj.		Ibid	Rev. J. B. Reade.	
From β to γ Urs. Min.		Ibid	Id.	
From 87 Draconis to α Draconis.		Ibid	Id.	
From 4° above Polaris and went from W. to E.	It described a wavy path.	Ibid	Id.	
From half-way between β and ϑ Urs. Min. passed through γ Urs. Min. and went a few degrees towards ι Draconis.		Ibid	F. Vnt. Fasel, Esq.	
From λ Draconis to the Pointers in Urs. Maj.		Ibid	Id.	
From ζ Cygni to within 4° N. of α Delphini.		Ibid	Id.	
From 3° S. of Markab, and went from E. to W. passing above ζ Pegasi.		Ibid	Rev. J. B. Reade.	
From half-way between δ and α Urs. Min. and went from E. to W.		Ibid	Id.	
From the mouth of the Dragon, i. e. from μ Draconis, passed through λ and μ Coronæ Borealis, and proceeded to δ Bootis and vanished beyond it within a few degrees of the horizon.	The extent of the train was 30°, and the whole of it was visible at the same time before the head vanished.	Ibid	Id.	

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or duration.
1853.	h m s				
Sept. 6	12 32 14	4th mag.	Blue	No train	Rapid
10	8 32 39	2nd mag.	Orange	Train	Moderate
	10 7 52 p.m.	1st. mag.	Brighter than α Lyræ, and reddish.	Train	Slow
	10 14 3 p.m.	4th mag.	Yellow	Train	Rapid
	10 19 43 p.m.	2nd mag.	Orange	Train	Slow
	10 33 51 p.m.	4th mag.	Blue	No train	Rapid
	10 52 39 p.m.	4th mag.	Red	Train	Rapid
	11 22 54	2nd mag.	Orange-red	Train	Rapid
	11 23 5 p.m.	4th mag.	Yellow	Train	Rapid
	11 31 21 p.m.	2nd mag.	Orange-red	Train like a semicircle	Rapid
	11 34 35 p.m.	3rd mag.	Yellow	Train	Rapid
	11 42 45	4th mag.	Blue	Train	Rapid
	11 45 25	2nd mag.	Yellow	No train	Rapid
	11 47 25	4th mag.	Blue	Train	Rapid
	11 55 26	3rd mag.	Yellow		Slow
	11 56 11 p.m.	3rd mag.	Blue	Train	Rapid
	11 58 p.m.	4th mag.	Blue		Rapid
	12 2 10	4th mag.	Blue		Rapid
	12 6 6	3rd mag.	Yellow	Train	Moderate

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
From under β and γ Urs. Min., and went from E. to W.		Stone	Rev. J. B. Reade.	
From H 28 Camelopardalis, or 10° below Polaris, and proceeded about 10° towards X Urs. Maj.		Ibid.	F. V. Fasel, Esq.	
From between λ and ϖ Lyræ, and went to θ Lyræ.		Ibid.	Id.	
From β Draconis to ϖ Lyræ		Ibid.	Id.	
From about 2° W. of β Urs. Maj., and vanished about 1° below χ Urs. Maj.		Ibid.	Id.	
Through Aries from N. to S.		Ibid.	F. Vnt. Fasel, Esq., and Rev. J. B. Reade.	
From α Ophiuchi to within 4° N. of β Ophiuchi.		Ibid.	F. V. Fasel, Esq.	
Started between η and ι Piscium, and about 3° S.W. of η, and went to μ Piscium.		Ibid.	Id.	
From about the same point as the preceding one; it went towards α Piscium, and vanished within 3° E. of υ (*upsilon*) and 4° 30′ N. of α Piscium.		Ibid.	Id.	
Started between Markab and Algenib, and within 7° E. of the former, and described, among the stars 76 S, and 65 Pegasi, a curve, like a semicircle, which terminated exactly at Markab.		Ibid.	Id.	
From half way between ϖ and ξ Herculis, passed S. of ι Herculis, and vanished half way between ζ and δ Herculis.		Ibid.	Id.	
From β Draconis to ϑ Herculis.		Ibid.	F. Vnt. Fasel, Esq., and Rev. J. B. Reade.	
From β Ophiuchi to the horizon.		Ibid.	Rev. J. B. Reade.	
From *f* and *e* Custodis Messium to Polaris.		Ibid.	Id.	
From ϖ Draconis to ρ Draconis.		Ibid.	F. Vnt. Fasel, Esq.	
From ϑ Aquarii to half way to ϑ Antinoi.		Ibid.	Rev. J. B. Reade.	
From α Cephei, and went about 10° towards γ Draconis.		Ibid.	Id.	
From ξ and σ Tauri, and went a few degrees due E.		Ibid.	Id.	
From a little below Capella, passed through β Aurigæ, and went 4° beyond it.		Ibid.	Id.	

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity of duration.
1853. Sept. 11	h m s 8 17 32 p.m.	2nd mag.	Yellow	Train	Moderate
18	S. M. T. 7 50 4 p.m.	1st mag.	Red	Train	Rapid
20	7 48 52 p.m.	1st mag., and as bright as α Andromedæ.	Orange-red	Train	Moderate
23	7 49 3 p.m.	3rd mag.	Yellow	Train	Rapid
	8 6 28 p.m.	4th mag.	White	Train	Very rapid
24	8 41 55 p.m.	2nd mag.	Orange	Train	Rapid
	8 44 35 p.m.	4th mag.	Blue		Moderate
	9 21 40 p.m.	4th mag.	White		Rapid
25	7 11 35 p.m.	1st mag., as large as Jupiter, and brighter than α Lyræ.	Orange	A wavy train 	Moderate
	7 17 15 p.m.	3rd mag.	White	Train	Rapid
	7 38 p.m.	2nd mag.	Yellow		Rapid
	7 47 54 p.m.	4th mag.	Yellow		Moderate
Oct. 2	8 16 6 p.m.	4th mag.	Yellow	Train	Rapid
	8 26 36 p.m.	5th mag.	Whitish	Train	Rapid
3	7 43 17 p.m.	1st mag.	Orange	Beaded train	Moderate

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
From about half way between Polaris and γ Cephei, and went towards β Cephei, and vanished a little below it.	....	Stone	F. V. Fasel, Esq.	
From ο Draconis, went from W. to E., and vanished within a degree S. of π Draconis.	....	Ibid...............	Id.	
From about 2° W. of μ Andromedæ, and went about 10° towards ζ Cassiopeiæ.	....	Ibid...............	Id.	
From κ (kappa) Draconis to ι (iota) Draconis.	....	Ibid...............	Id.	
From 2° W. of ψ Cassiopeiæ to γ Cassiopeiæ.	....	Ibid...............	Id.	
From 1° above and E. of α Andromedæ; passed W. of Algenib, and disappeared at k (86) Pegasi.	....	Ibid...............	Id.	
From about 3° W. of β Lyræ to ξ Herculis.	....	Ibid...............	Id.	
From half way between κ (kappa) and β Lyræ to C H 103 Herculis.	....	Ibid...............	Id.	
From half way between α Andromedæ and Scheat, to half way between Markab and Algenib.	The head described its path in a zigzag, giving out sparks at the same time. The wind was blowing almost a gale from W. by N.	Ibid...............	Id.	
From 4° 30′ W. of ι (iota) Andromedæ to Scheat.	....	Ibid...............	Id.	
From δ Urs. Min. to nearly half way between H 32 and H 30 Camelopardalis.	....	Ibid...............	Id.	
From δ Herculis to within 2° of N.E. of α Herculis.	....	Ibid...............	Id.	
From 3° E. of γ Urs Min., passed between γ and β, its direction being N. by W., and vanished within 4° W. of and below β Urs. Min.	....	Ibid...............	Id.	
From 3° N. of ϑ and C H 209 Bootis, and vanished within 1° W. of 44 Bootis.	....	Ibid...............	Id.	
From between ξ and ο Herculis, passed through 106 Cerberi, and vanished about 4° W. of m rami pomiferi.	The train was very bright towards its commencement; it appeared to emit sparks, and was visible a short time after the head had accomplished its course and had vanished.	Ibid...............	Id.	

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or duration.
1853. Oct. 3	S. M. T. h m s 7 50 37 p.m.	4th mag.	White	Train	Rather rapid
	8 3 51 p.m.	2nd mag.	Red	Beaded train, which increased as it proceeded.	Slow
	8 9 36 p.m.	1st mag.	Orange	Train	Rapid
	8 15 21	1st mag.	Orange-red	Beaded train	Moderate
	8 18 51 p.m.	4th mag.	Yellow	Train	Very rapid
	8 23 19 p.m.	Larger than α Lyræ, and almost the size of Jupiter.	Orange	Train	Very slow
	8 45 35	2nd mag.	Yellow	Train	Rapid
	8 48 40	2nd mag.	Blue	Train	Moderate
	9 24 3	2nd mag.	Red	Train	Moderate
5	7 6 12 p.m.	2nd mag.	Orange		Moderate
	7 10 22 p.m.	1st mag.	Orange	Train	Moderate
	7 34 57 p.m.	1st mag.	Blue	Beaded train	Moderate
	7 35 12 p.m.	2nd mag.	Blue	Train	Rapid
	7 43 7 p.m.	2nd mag.	Red		Very slow
	7 49 58	4th mag.	Blue	Train	Rapid
	7 57 58	1st mag.	Red	Train	Moderate
	8 4 33 p.m.	4th mag.	Blue		Rapid
	8 40 53	3rd mag.	Orange	Train	Rapid
	8 54 8 p.m.	2nd mag.	Red	Train	Moderate
9	6 51 4 p.m.	2nd mag.	Red	Train	Moderate

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
From S 1 Tauri Poniatowski to Ras Alhagus (α Ophiuchi).	....	Stone	F. V. Fasel, Esq.	
From half way between ξ Draconis and α Cephei, and went to α Cephei.	....	Ibid................	Id.	
From 2° W. of φ Herculis; passed between υ (upsilon) and τ (tau) Herculis, and disappeared within 4° beyond the last star mentioned.	....	Ibid................	Id.	
From 2° E. of υ Herculis, and went to ζ Herculis.	....	Ibid................	Id.	
From about 4° N. by E. of S 1 Tauri Poniatowski to α Tauri Poniatowski.	....	Ibid................	Id.	
From η Draconis to within 3° of μ and ν 1 Draconis.	This meteor first made its appearance as a star of 6th mag., and gradually increased in size, but did not start off in its path before having attained to the magnitude of Jupiter.	Ibid................	Id.	
From χ Cygni to γ Lyræ	....	Ibid................	Id.	
From about η Sagittæ to α Delphini.	....	Ibid................	Id.	
From 1° 30′ E. of φ 42 Andromedæ to γ Andromedæ.	....	Ibid................	Id.	
From about G (106) Rami Pomiferi, and went about 7° due S.	....	Ibid................	Id.	
From about β to ρ Bootis	....	Ibid...............	Id.	
From α Lyræ to τ Herculis ...	....	Ibid................	Rev. J. B. Reade.	
Under the head of Draco, went from E. to W.	It appeared very low.	Ibid................	Id.	
From between ι and ζ Andromedæ, crossed the head of Piscis Borealis, and vanished a little below β Andromedæ.	The head was very compact.	Ibid................	Id.	
From about ϑ Draconis, and vanished within 2° E. of CH 209 Bootis.	....	Ibid................	F. V. Fasel, Esq.	
From about E Cerberi to σ Ophiuchi.	....	Ibid................	Id.	
From *f* Custodis Messium to ε Cassiopeiæ.	....	Ibid................	Id.	
From 6° S.S.E. of ϑ Draconis to τ Herculis.	....	Ibid................	Id.	
From 1° N. of υ Andromedæ to Mirach.	....	Ibid................	Id.	
From CH 122 Urs. Maj. to β Ursæ Majoris.	....	Ibid,................	Id.	

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or duration.
1853. Oct. 22	h m s 6 43 17 p.m.	2nd mag.	Red	Train	Rapid
	6 48 14	3rd mag.	Red	Beaded train	Moderate
25	6 48 2 p.m.	1st mag.	White		Rapid
25	6 57 37 p.m.	3rd mag.	White		Rapid
	6 58 2 p.m.	3rd mag.	Reddish	Train	Moderate
	7 1 2 p.m.	3rd mag.	White		Moderate
	7 3 32 p.m.	1st mag.	Orange	Train	Moderate
	8 4 2 p.m.	3rd mag.	Red		Rapid
	8 15 3 p.m.	4th mag.	White		Rapid
Nov. 1	7 46 8 p.m.	2nd mag.	White	Train	Rapid
	8 42 50 p.m.	2nd mag.	Red	Long train	Rapid
	8 47 27 p.m.	1st mag.	Orange-red	Train	Rapid
2	7 43 37 p.m.	2nd mag.	White	Train	Rapid
	7 56 57 p.m.	2nd mag.	Yellow	Train	Moderate
	7 57 57 p.m.	2nd mag.	Orange	Train	Rapid
	8 13 58 p.m.	1st mag.	Red	Beaded train	Moderate
	8 36 8 p.m.	1st mag.	Red	Train	Rather slow
	9 3 53 p.m.	3rd mag.	White		Rapid
	9 24 54 p.m.	4th mag.	Orange	Train	Rapid
3	7 22 3 p.m.	4th mag.	White		Rapid
	8 8 23 p.m.	1st mag.	Orange-red	Train	Rather slow

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
From about D (97) Rami pomiferi, and travelled about 9° in a direct line towards ϑ Serpentis.		Stone	F. V. Fasel, Esq.	
From N (H 4.) Camelopardalis to within 3° W. of K (H 19.) Camelopardalis.		Ibid.	Id.	
From 1° S. of κ Andromedæ to 43 Piscium.		Ibid.	C. V. Oliver, Esq.	
From 1° N.W. of υ (upsilon) Herculis, passed between π and σ, and vanished 2° N. of σ Herculis.		Ibid.	F. V. Fasel, Esq.	
From 1° W. of η Piscium, and went to ο Piscium.		Ibid.	Id.	
From 1° 30′ W. of κ Aquarii, and travelled about 14° in a direct line towards ϑ Antinoi.		Ibid.	C. V. Oliver, Esq.	
From between υ and β Draconis, and disappeared between π and ρ Herculis.		Ibid.	F. V. Fasel, Esq.	
From between π and η Herculis, passed between ζ and ε and vanished at S. (50) Herculis.		Ibid.	Id.	
From 5° S. of ϑ Draconis, and disappeared between τ and υ Herculis.		Ibid.	Id.	
From about *d* Draconis to 5° 30′ S.W. of γ Draconis.		Ibid.	Id.	
From about *c* (32) Pegasi to about μ (17) Delphini.		Ibid.	Id.	
From about 3° E.N.E. of γ Lyræ, and vanished within 10° due W. of β Cygni.		Ibid.	Id.	
From δ Sagittæ to φ Aquilæ ...		Ibid.	Id.	
From γ Urs. Min. to ι (iota) Draconis.		Ibid.	Id.	
From about 2° E. of ε Sagittæ, and travelled about 10° towards ε Delphini.		Ibid.	Id.	
From about 2° E. of γ Delphini, passed through ϑ Capricorni, and vanished 3° beyond it.		Ibid.	Id.	
From 1° W. of δ Aurigæ to a little beyond *d* Lyncis.		Ibid.	Id.	
From 2° N.E. of η Pegasi, passed just below π Pegasi, and disappeared 1° S. of υ (upsilon) Cygni.		Ibid.	Id.	
From γ Urs. Min. and disappeared between ι (iota) and ϑ Draconis.		Ibid.	Id.	
From 4° N.E. of σ Herculis to within 3° N. of ν 2 Herculis.		Ibid.	Id.	
From about 1° S. of ϑ Cygni to 1° N. of κ (kappa) Lyræ.	Appeared low	Ibid.	Id.	

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or duration.
1853.	h m s				
Nov. 3	8 21 20 p.m.	1st mag. and as bright as α Lyræ.	Red	Train	Rapid
8	9 18 50	1st mag.	Red		Rapid
9	8 17 20	1st mag.	Brilliant red	Train	Slow; about 3 seconds' duration.
19	5 57 35 p.m.	2nd mag.	Red		Rapid
	6 13 4 p.m.	1st mag.	Red	Beaded train	Slow
	6 30 19 p.m.	1st mag.	Brilliant red		Instantaneous
	7 18 24	1st mag. or rather the size of Jupiter, but not so bright.	White	No train	Slow
20	7 9 p.m.	2nd mag.	Reddish	Beaded train	Moderate
	7 10 9 p.m.	1st mag.	White	Wavy train	Rapid
	7 39 12 p.m.	2nd mag.	White	Train	Rapid
	10 10 19 p.m.	3rd mag.	Red	Train	Very rapid
21	5 47 36 p.m.	3rd mag.	Orange	Train	Rapid
	5 51 2 p.m.	4th mag.	Whitish		Moderate
	5 54 43	3rd mag.	White	Train	Very rapid
	6 37 54 p.m.	2nd mag.	Red		Slow
	6 48 46 p.m.	2nd mag.	Orange-red		Rapid
	7 1 4 p.m.	2nd mag.	Orange		Very rapid
	7 10 31	5th mag.	White	Train	Rapid
	7 18 46 p.m.	4th mag.	Red	Long-beaded train	Rapid
22	7 9 28 p.m.	2nd mag.	Red	Wavy train	Rapid
	9 14 13 p.m.	4th mag.	Orange	Train	Rapid

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
From between η and ζ Aquarii to within 3° N.W. of δ Aquarii.	....	Stone	F. V. Fasel, Esq.	
From about H 24 Camelopardalis to about ϑ Urs. Maj.	....	Ibid.................	Id.	
From about 2° W. of H 22 Camelopardalis to about ϱ Urs. Maj.	....	Ibid.................	Id.	
From about δ to η Andromedæ.	....	Ibid.................	Id.	
From ι (iota) Draconis to κ (kappa) Bootis.	....	Ibid.................	Id.	
From η Urs. Min. to within 2° E. of γ Urs. Min.	....	Ibid.................	Id.	
From about θ Ceti, passed below η and vanished within 3° E. of β Ceti.	Appeared verymuch like a Roman candle.	Ibid.................	Id.	
From υ Cygni, passed through ι, and proceeded about 7° towards φ Cygni.	....	Ibid.................	Id.	
From half-way between γ Delphini and ζ Cygni, crossed Vulpecula and vanished within 4° E. of *b* (6) Anseris.	....	Ibid	W. Tomkyns, Esq	
From δ Aquilæ to very near the horizon.	....	Ibid	W. Tomkyns, Esq	
From 4° S. of α Andromedæ, passed within 4° or 5° E. of Markab, and vanished within 6° 20′ E. of ζ Pegasi.	....	Ibid.................	F. V. Fasel, Esq.	
From κ (kappa) to α Draconis .	....	Ibid.................	Id.	
From between ξ and υ Draconis, and proceeded about 8° in a direct line to γ Urs. Min.	....	Ibid.................	Id.	
From about 4° S. of ν (nu) Cygni, passed between ι and γ, and vanished within 2° E. of η Cygni.	....	Ibid.................	W. Tomkyns, Esq	
From about *g* to ι Pegasi	....	Ibid.................	F. V. Fasel, Esq.	
From about 5° S. of α Cephei, and proceeded about 8° towards α Cygni.	....	Ibid.................	Id.	
From ξ Draconis to κ (kappa) Cygni.	....	Ibid.................	Id.	
From 7° S. of β Piscium, and travelled about 8° towards ϑ Aquarii.	....	Ibid.................	Id.	
From 4° W. of γ Cephei, passed between β and γ, and vanished within 2° W. of ζ Cephei.	....	Ibid.................	Id.	
From about ξ Cygni, passed between γ and ι, and vanished within 3° S.S.W. of γ Cygni.	....	Ibid.................	Id.	
From about 2° W. of υ Cygni, and vanished within 2° E. of ι (iota) Cygni.	....	Ibid.................	Id.	

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or duration.
1853. Nov. 22	h m s 9 17 18 p.m.	4th mag.	Reddish	Beaded train	Rapid
	9 19 47	5th mag.	White	Train	Rapid
23	6 1 36	2nd mag.	White	No train	Slow

Luminous Meteors observed 1853–54,

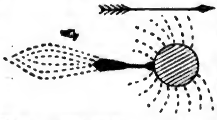
Sept. 23	8 3 p.m.	Large meteor	White	Leaving a train	Slow
Oct. 2	10 28 p.m.	Small	White	None	Quick
25	7 13 p.m.	Small	White	None	Slow
30	10 12 p.m.	Small	White	Brilliant, none	Rapid
1854. July 22	11 10 p.m.	Large	White, brilliant.	Long train of sparks	Slow
23	10 35 p.m.	Large	White	No train	Slow
	10 36 p.m.	Small	White	No train	Rapid
	11 4 p.m.	Large	White	Appeared stationary; exploded; throwing off a great light.	
Aug. 30	10 15 p.m.		White	No train	Slow
	10 18 p.m.		White	No train	Quick
	10 20 p.m.	Large	Reddish	Long train of brilliant sparks.	Slow
Sept. 1	9 57 p.m.		Bright	No train	Quick

Luminous Meteors observed 1853–54,

Sept. 1	13 15				
Oct. 2	9 52	= to Sirius	of Sirius	Train	Slowly
Nov. 1	9 to 13				
1854. Feb. 25	8 16	= 4th mag.*		Fragments	Slowly

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
From about 14 Draconis, passed between η and ζ Draconis and proceeded about 6° in a direct line to γ Draconis.		Stone	F. V. Fasel, Esq.	
From Scheat to about 1° W. of φ Pegasi.		Ibid.	Id.	
From *k* Capellæ to ν Aurigæ		Ibid.	W. Tomkyns, Esq.	

by J. King Watts, F.R.G.S., St. Ives, Hunts.

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
From zenith by α Persei down towards North East.	Divided into two, one portion vanishing several seconds before the other.	St. Ives, Huntingdonshire.	J. King Watts.	
From Pleiades to Eastward		Ibid.	Id.	
Across Ursa Major to North		Ibid.	Id.	
From Lyra to Delphinus		Ibid.	Id.	
From Lyra, passing Polaris		Ibid.	Id.	
From Cassiopeia to West		Ibid.	Id.	
Same course		Ibid.	Id.	
Below α Cygni		Ibid.	Id.	
From α Persei to North		Ibid.	Id.	
From Ursa Minor to West		Ibid.	Id.	
From Polaris to α Ursæ Majoris 	This was a beautiful object, and threw off a strong light. The nucleus became invisible several seconds before the sparks had disappeared.	Ibid.	Id.	
From α Cassiopeiæ to α Cygni.		Ibid.	Id.	

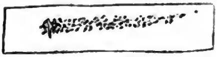
by E. J. Lowe, Esq., F.R.A.S.

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
	Several meteors	Highfield House Observatory.	A. Lowe, Esq.	E. J. Lowe's MS.
From zenith down to S.E.		Ibid.	Ibid.	Ibid.
	Many large meteors	Ibid.	E. J. Lowe, Esq.	Ibid.
γ Pegasi towards ι Piscium. Disappeared *exactly* as it reached the N. edge of zodiacal light, on giving the impression that this phænomenon had caused its disappearance. This is possible, because stars of the 4th mag. within the *light* were not visible.	Zodiacal light	Observatory, Beeston.	Ibid.	Ibid.

Date.	Hour.	Appearance and magnitude.	Brightness and colour.	Train or sparks.	Velocity or duration.
1854.	h m				
Mar. 4	9 5	Small	Orange	Many sparks	Slowly
30	9 3	Small			
Apr. 1	10 0	Very large	Bluish	Globe	Slowly
10	8 12	=twice Mars	Blue	No train	0·2^{s}
14	8 43 20	=2nd mag.*	Deep red	No train	0·5^{s}
19	12 3	=2nd mag.*	Orange-red	Streak	0·2^{s}
20	8 0	twice size ♃	Blue	Globe	Slow
Aug. 30	8 30	=α Lyræ	White	Short tail	Very slow
	8 30	=α Lyræ	White	Short tail	Very slow
Sept. 13	8 20	=3rd mag.*	Ruddy	No tail	Very rapid
	10 50	=1st mag.*			Rapid
	9 20	=2nd mag.*	White	Streak	Rapid
17	9 22	=6th mag.*			
	9 31	=♃	Yellow	Train	Rapid
	10 28	=1st mag.*	Colourless	Train	Rapid
	10 36	=1st mag.*	Colourless	Train	Rapid
	12 47	=1st mag.*	Colourless	Streak	Rapid
	12 48	=3rd mag.*	Colourless	Streak	Rapid
	12 49	=1st mag.*	Yellowish	Streak	Very rapid

Miscellaneous

1853. Oct. 28	h m s 3 57 p.m.	Large, ½ diameter of moon.	Very bright	Train with prismatic tints, 2° broad and 5° long.	About 3 secs. ex- ploded, after ing through 15°.
1854. April 1	10 5 p.m.	Bright meteor	At first full red, changed to blue, increased in brightness, & vanished.	Leaving a strong streak of light for a second after disappearance.	5 or 6 secs.
	Same evening.	Several smaller meteors, replaced by the formation of a white cloud.			

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
Horizontally moved northwards from 1° above the Pleiades.		Observatory, Beeston.	E. J. Lowe, Esq.	E. J. Lowe's MS.
Perpendic. down through α Tauri.		Ibid.	Ibid.	Ibid.
Perpendic. down in S.E. to within 15° of horizon. Broke into several fragments.	As light as day ...	Ibid.	S. Watson, Esq..	Ibid.
Passed through δ Hydræ and No. 13 Canis Minoris. Increased from a point, and burst when at maximum brightness into several fragments.		Ibid.	E. J. Lowe, Esq.	Ibid.
Perpendic. down through β Cassiopeiæ. Broke into fragments.	Increased in brightness.	Ibid.	Ibid.	Ibid.
Perpendic. down from δ Ursæ Minoris.		Ibid.	Ibid.	Ibid.
Rose up in E.S.E. and burst in zenith.		Highfield House Observatory.	A. Lowe, Esq....	Ibid.
From λ to between β and δ Andromedæ.		Ibid.	A. S. H. Lowe, Esq.	Ibid.
From λ to between δ and β Andromedæ.		Nottingham......	Rev. K. Swann .	Ibid.
From α Herculis to near α Serpentis.		Ibid.	Ibid.	Ibid.
Downwards in N.W.		Obser. Beeston .	Mrs. E. J. Lowe.	Ibid.
From β Cygni perpendic. down		Highfield House Observatory.	E. J. Lowe, Esq.	Ibid.
From α Coronæ northwards ..		Ibid.	Ibid.	Ibid.
From γ Trianguli to between α and β Arietis.	Many minute meteors.	Ibid.	Ibid.	Ibid.
				
From β Cassiopeiæ		Ibid.	Ibid.	Ibid.
From γ Pegasi towards zenith .		Ibid.	Mrs. E. J. Lowe.	Ibid.
Passed midway between α and β and between δ and γ Ursæ Majoris, passing across the stars No. 42 Ursæ Majoris and No. 7 Canum Venaticorum.		Observatory, Beeston.	E. J. Lowe, Esq.	Ibid.
From λ Ceti to near α Ceti ...		Ibid.	Ibid.	Ibid.
Passed 1° under Polaris and crossed between γ and θ Ursæ Minoris.	Between 7h and 15h there could not have been less than 200 meteors.	Ibid.	Ibid.	Ibid.

Observations.

Direction or altitude.	General remarks.	Place.	Observer.	Reference.
Alt. at disappearance about 10° E. of N.		Beeston, Mildenhall, Burnham and other places.	E. J. Lowe, Esq., and several other observers.	MS. See Appendix, No. IV.
From S.E. to N.W. horizontally, south of Regulus. Alt. 35°.	Light seen within doors, and with candle-light.	Bracondale, Norwich.	J. Crompton, Esq.	MS. communication.

Observations of Meteors, made at Midhurst, by C. Bulard, *B.A., M.B.M.S., &c., as found in Argelander's Ura-*

No.	Date.	Hour. Greenwich Mean Time	Apparent Magnitude.	Brightness and colour.	Velocity or Duration.	Mean places for 1840 of A.		Mean places for 1840 of B.	
						R.A.	Decl.	R.A.	Decl.
	1853.	h m s			s				
183	Aug. 10	9 51 45	β Pegasi ……	White …	0·5	60° 42′	61° 26′	74° 10′	66° 41′
184		9 58 15	β Pegasi ……	Blue……	0·5	55 50	62 36	46 30	58 00
185		10 7 28	β Pegasi ……	Blue……	0·25	325 38	10 15	326 30	6 20
186		10 7 30	β Pegasi ……	Blue……	0·25	324 46	1 57	319 30	−0 7
187		10 15 30	β Pegasi ……	Blue……	0·20	328 15	2 45	321 30	−3 45
188		10 20 00	β Pegasi ……	Blue……	0·25	344 00	20 10	335 30	12 50
189		10 23 30	β Pegasi ……	Blue……	0·50	332 30	32 12	328 00	22 30
190		10 31 00	α Lyræ × 2 …	Blue……	0·50	70 00	81 00	95 51	87 00
191	11	10 48 00	α Arietis ……	Blue……	0·5	312 00	20 00	305 00	15 00
192		10 52 05	α Arietis ……	Blue……	0·5	3 56	26 00	360 00	2 55
193	12	10 6 00	α Lyræ………	Blue……	0·25	21 00	58 00	2 15	47 50
194	27	8 42 00	Arcturus × 4…	Red ……	1·25	200 00	56 00	187 30	49 00
195	28	10 28 00	β Pegasi ……	Blue……	0·5	273 00	37 30	266 30	26 00
196		10 38 00	α Lyræ × 2 …	White …	1·5	173 00	56 00	162 00	58 00
197		11 20 00	α Lyræ − 0·25.	Blue……	0·5	124 00	56 30	….	….
198	29	11 30 30	α Lyræ………	Blue……	0·25	10 00	53 30	21 30	49 50
199	Oct. 20	10 9 26	α Lyræ × 4 …	Blue……	1·5	1 43	26 24	333 35	14 21
200	28	6 40 26	α Lyræ………	Blue……	0·5	137 46	75 00	156 00	72 00
201		9 46 26	α Tauri ……	Red ……	0·5	70 00	80 25	85 9	87 17
202	Nov. 1	9 56 56	α Tauri ……	Red ……	0·5	318 00	31 56	[No places are given for such small meteors.]	
203		9 58 56	β Pegasi ……	Blue……	0·5	327 00	12 10		
204	3	8 38 56	β Pegasi ……	Blue……	0·5	296 00	27 00		
205		10 36 56	β Pegasi ……	Blue……	0·25	88 00	43 20		
206		10 46 16	α Lyræ × 3 …	Blue……	1·0	3 00	64 30	5 00	40 00
207		11 13 21	β Pegasi ……	Blue……	0·5	42 00	26 30	….	
208		12 23 56	β Pegasi ……	Blue……	0·25	293 00	48 00	302 00	46 00
209	8	12 43 56	β Canis ……	Blue……	1·0	109 40	8 36	….	….
210		13 20 41	β Pegasi ……	Blue-red.	0·5	357 30	37 50	….	…..

Nov. 9th, 10th, 11th and 12th, ☽ shining, no meteor seen.

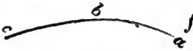
APPENDIX.

No. I.—On a Luminous Beam.

Extracts of two letters from W. R. Birt, *Esq. to* Prof. Powell.

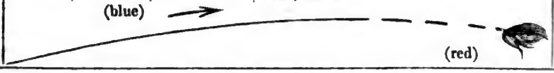
[Though the phænomenon here described does not strictly come under the denomination of luminous meteors, yet, as from certain theoretical inferences made at the end, it *may* have a connection with the subject, the communication is here inserted.]

[Jan. 15, 1850.]—"I obtained an observation of an interesting phænomenon on the evening of the 7th inst. It was a faint but very distinct light, less bright and more diffused than the Via Lactea, which was very distinct at the time. It occupied the south-west portion of the heavens, possessed a trian-

and mean places of a, b, c 

for 1840, *from Stars of Comparison,*
nometria Nova.

Mean places for 1840 of C.		Place of Observation.		Train or sparks. Remarks.	Observer.	Reference.
R.A.	Decl.	L. from G.	Lat.			
° ′	° ′	m s	° ′ ″			
86 00	60 38	−2 56	+50 00 00		C. Bulard, Esq.	Argelander's Uranometria Nova.
44 45	52 6	−2 56	+50 00 00			
328 30	2 00	−2 56	+50 00 00			
313 2	− 5 20	−2 56	+50 00 00			
318 35	−12 5	−2 56	+50 00 00			
333 21	− 2 11	−2 56	+50 00 00	Train of light.		
327 00	13 45	−2 56	+50 00 00			
171 00	85 15	−2 56	+50 00 00	Train of light.		
302 15	9 42	−2 56	+50 00 00			
362 50	18 00	−2 56	+50 00 00			
359 00	28 30	−2 56	+50 00 00			
176 00	38 00	−2 56	+50 00 00	Train.		
259 00	13 30	−2 56	+50 00 00			
148 00	59 30	−2 56	+50 00 00	Train.		
143 40	56 20	−2 56	+50 00 00			
28 00	46 00	−2 56	+50 59 46			
313 40	−7 29	−2 56	+50 59 46	Motion very swift, described a very large arc.		
164 00	67 4	−2 56	+50 59 46	☽ shining.		
205 00	87 20	−2 56	+50 59 46			
308 00	28 00	−2 56	+50 59 46			
325 30	2 5	−2 56	+50 59 46			
294 46	13 20	−2 56	+50 59 46			
106 00	40 00	−2 56	+50 59 46	Cloudy on the 4th, 5th, 6th, 7th.		
3 00	10 00	−2 56	+50 59 46			
30 00	23 45	−2 56	+50 59 46			
313 00	36 30	−2 56	+50 59 46	No meteor seen between 11ʰ and 12ʰ.		
98 20	2 50	−2 56	+50 59 46			
344 45	44 00	−2 56	+50 59 46	Number 210 appeared blue, and disappeared red, thus—		



gular form, had its apex near the planet Saturn, and was inclined to the horizon at about the *same angle* as the *equinoctial*, in this respect being totally different from the zodiacal light. That the phænomenon was of a persistent character, at least for six days, appears pretty evident from my having obtained another view of it, though not under such favourable circumstances, on the evening of the 13th, at the same hour, 7 p.m. On the last occasion, its lower portion was concealed by mist, but the light above the mist was very discernible, and the dark space of sky between the faint light and the Via Lactea very distinct. The edge was decidedly rectilinear, and almost parallel with the equinoctial, as determined by comparison with the stars α and γ Pegasi; and the apex extended beyond the planet Saturn."

[Feb. 14, 1850.]—"I have received a very interesting communication from the Rev. J. B. Reade, Vicar of Stone, near Aylesbury, relative to the luminous beam which I first observed early in January. I have obtained observations of this interesting phænomenon on every clear evening during the absence of the moon since, in the course of which some very important features have presented themselves: the apex has very steadily advanced along the *ecliptic*, and the phænomenon has increased in brilliancy with alternations. When I first observed it, the apex coincided with the position of Saturn; last evening, the luminous triangle being very distinct, the light stronger than I had before observed it, and forming a rather conspicuous object in the west, the apex was observed about 29° ♈. This progression is rather less than the sun's daily change of place in the ecliptic. The position which the phænomenon now occupies may be thus marked out; a line passing from 29° ♈ near and to the south of γ Pegasi. leaving α Pegasi more to the north than γ, and meeting the horizon about one-quarter point north of W. by N., will indicate the upper or northern edge. A line drawn from the apex 29° ♈ near to and to the south of Saturn, will point out the lower or southern edge. It will be observed from this description, that the main body of the light is seen from this observatory between Saturn and γ Pegasi, and nearly filling that space; the axis may be described by a line passing from 29° ♈ past ε and δ Piscis, crossing the equinoctial colure at 5° north dec., and meeting the equinoctial about 340° Æ. Such is the general position which the luminous triangle now occupies, and it was not very materially different on the evening of the 7th. When Mr. Reade observed it, he evidently saw a similar appearance to that which I observed, but it was in a different position; instead of the upper or northern edge cutting the horizon at W. by N., the lower or southern edge rose from this point, so that the whole body of light was seen more northerly at Stone by its own breadth; this is very remarkable: Mr. Reade has sent me a drawing of the triangle, from which it appears that the apex was seen between the stars α Andromedæ and γ Pegasi; the upper edge passed very near but to the north of β Pegasi and ζ Cygni, and the lower very near indeed to α Pegasi. Mr. Reade's observations are corroborated by those of Mr. Grace, who saw the phænomenon on the evening of the 6th; he observed the apex in the square of Pegasus. This large displacement for so small a distance between the stations is very important in tracing out the cause of the phænomenon, and it would be very desirable to augment the number of stations in March, if (as it appears very probable) the triangle should appear in the early part when the moon is absent."

Mr. Birt adds a conjectural suggestion that this beam may be the appearance of part of a ring of cosmical matter reflecting the sun's rays, inclined to the plane of the earth's orbit at about the same angle as the equator, and having its node situated near the first point of Aries, not crossing the earth's *path* at that point, but approaching it most nearly towards the end of Aquarius, or in the beginning of August; at which time he points out the direction of a line from the earth coinciding with the direction of the supposed ring, *i.e.* nearly parallel to the equator, will point to the constellations Cassiopeia through Perseus and Capella. These hypothetical conditions, he thinks, all concur in pointing to this ring of cosmical matter as the probable origin of the August star-showers; while similar considerations as to the zodiacal beam, would connect that with the November period.

No. II.—*Extract of a letter from Mr. Fasel accompanying his observations.*

"Stone Vicarage, Aylesbury, Bucks.

"The enclosed observations of luminous meteors were witnessed chiefly by myself and the Rev. J. B. Reade; being the continuation of the report sent to you in September last. The list is not very extensive, but it is not for want of a constant and careful look out that so little information has been gathered. On every clear night the heavenly field has been surveyed for hours, having myself been watching from about 7 p.m. to 10 p.m., and sometimes later. From the beginning of August last to the end of November, 147 meteors only have been registered. This year has been remarkable for the paucity of shooting stars. I enclose four diagrams (Plates VI. VII. VIII. IX.) of the paths of the meteors, with four planispheres, in which the stars are exhibited as they actually appear with relation to each other in latitude 52° N., at the hour indicated. The diagram Plate VI. shows the paths of 34 meteors seen in August 1851 and 1852; Plate VII., the paths of 87 meteors witnessed in September 1851 and 1852; Plate VIII., the paths of 86 meteors observed in September and October 1853; Plate IX., the paths of 36 meteors seen in November last. In the first two diagrams, the black arrows indicate the meteors seen in 1851; the dotted, those seen in 1852. In Plate VIII., the black arrows indicate the meteors seen in September last, and the dotted those seen in October. The paths of all the meteors were first laid down on the planispheres from the point of first appearance to that of extinction, and then counterdrawn on the other side. The numbers against the arrows indicate the magnitude of the meteors.

"*Rev. Prof. Powell.*" "F. VNT. FASEL."

No. III.—*Boguslawski's Researches.*

In Poggendorff's 'Annalen,' (supplementary volume iv.), M. George von Boguslawski has published a paper entitled 'Tenth Supplement to Chladni's Catalogues of Meteors,' &c., which he gives as his own first continuation of nine preceding supplements by Von Hoff and Kämtz, which have appeared in successive previous numbers of Gilbert's and Poggendorff's Annalen. This paper contains a considerable collection of notices of remarkable meteoric phænomena, and it is intended altogether as a prelude to a larger work on the subject, and includes a brief summary of points there to be treated in detail.

In these brief notices, omitting the ordinary observations of smaller shooting stars, he confines his descriptions chiefly to the large fire-balls, especially those attended by sparks, trains, explosions or other remarkable appearances; and to those phænomena, such as the fall of metallic masses, and especially the periodical star showers, which present any peculiar features of interest in a physical point of view.

This collection will be of peculiar value towards any examination of these more striking phænomena, which are probably the most calculated to guide us to some physical theory of their nature.

The title of his intended work is 'Die Sternschnuppen, feuerkugeln und Meteorite in ihrer kosmischen Bedeutung'.

He informs us that the catalogue of Chladni and von Hoff were brought up to the year 1836 by Kämtz. Latterly in most countries similar catalogues have been drawn up: he instances those of the British Association, Quetelet, and Chasles. The catalogue of the latter is from the year 583 to 1123; and it appears that from the year 741 for a century, many meteors always occurred in February, which Chasles identifies with the present November period, which in 125 years by means of a displacement of the orbit of these meteoric asteroids would advance one month further. He gives a short account of various other catalogues, those of Ed. Biot, Alex. Perry, Herrick, Quetelet, Coulvier Gravier, though they refer more to smaller falling stars than to fire-balls.

His own "supplementary catalogue" consists of two divisions; the first of meteoric stones, from 642 B.C. to 1835 A.D., includes only authenticated accounts, with the description and analyses of the masses found. He is anxious to gain some light on the hitherto uncertain point of the nature of the material which has been seen to fall from shooting stars or fire-balls:—the second part forms a continuation of the Chladni and Hoff catalogues from 1835 to 1850 (inc.) giving all the accounts he could find of *fire-balls and meteoric stones*; and here he avails himself of all the sources of information he could meet with, Silliman's Journal, British Association Catalogue, and a variety of smaller publications and papers, which it was laborious to select and arrange.

M. Boguslawski mentions an interesting work of M. F. S. Schweigger, an introduction to Mythology, as viewed in reference to natural science (Halle 1836), which pressed upon him some interesting considerations upon the signification of the "*meteorcultus*" of the ancients, and of their knowledge of the meteoric masses: these he will impart in his future work.

He alludes particularly to the system recommended and pursued by the British Association, of which an account is given in the Edinb. Phil. Journ., vol. l. p. 357. He remarks, "that a *general catalogue* of all the meteoric appearances on the earth, from which we could derive information as to the nature of these bodies and their distribution in time and space, can only be obtainable by a *uniformity* and *completeness* in the observations, and their being all communicated to one central depository, where all single catalogues may be compared and worked into one."

No. IV.—*Large meteor seen in the daytime.*

1853, October 28^d 3^h 57^m p.m. This extraordinary meteor moved nearly perpendicularly down, inclining to east. It was first seen as a circular body of about half the apparent diameter of the sun, being accompanied by a stream of light; afterwards it increased in size to almost the diameter of the sun, and then burst into fragments, with an explosion. The report of the explosion was from 1 second to 3 seconds after the meteor had disappeared, and resembled distant thunder. The meteor passed over 15° of space, disappearing 30° E. of N. at an altitude of about 10°, duration $3''$. It was very brilliant, shining with a somewhat yellow light. Soon afterwards, near the spot where it had disappeared, a band of prismatic colours was visible, being 2° wide and 5° in length. This phænomenon when first seen was as brilliant as a rainbow, but soon faded, finally disappearing in about 5 minutes. Clouds were dispersed over the sky, from behind one of which the meteor appeared and afterwards vanished behind a second cloud. The above description applies to a station 1 mile W. of Beeston Observatory as seen by Mrs. E. J. Lowe.

The Rev. R. B. Stewart gave a nearly similar description as seen by himself at Beeston.

Mr. W. Felkin saw the meteor also from Beeston; he thought it moved at first much more obliquely than afterwards. He saw it burst into fragments three different times as it moved along. It came from *behind* one cloud, and he is *positive* that it passed *beneath* a second cloud. [Query, would this be a fragment?—E. J. L.]

The Rev. Henry Evans observed the meteor from Mildenhall, Suffolk; it was circular, very bright, moved nearly perpendicularly down, inclining to E., and bearing a stream of light behind it.

From a letter signed H. E. Blyth, and dated Burnham near Lynn, Norfolk, the meteor is described as appearing in the NN.W., crossing the meridian, and disappearing in NN.E. at an altitude of from 5° to 10°, seen for $5''$. Looked as if it dropped near at hand, i.e. a mile or two off.

Mr. B. Huntman from West Retford saw the meteor. It resembled a comet, almost as bright as the sun. It took a direction almost N. to S. In one or two seconds the luminous appearance vanished, but a black point seemed to continue falling towards the earth. Mr. Huntman went into a field where he concluded it had fallen, but could not find it. He says there was a strong smell of sulphur in the field.

The Rev. J. Brooke of Colston Bassett near Bingham saw the meteor from five miles S. of Lincoln; it was going in a northerly direction and passing from S.W. to N.E. The form was somewhat like the sketch appended; when it burst it resembled a rocket bursting.

Mr. G. Warriner noticed it from Normanton Hotel near Wakefield; it appeared to vanish at an altitude of 20°.

It was seen also at Tunbridge.

From the explosion occurring so soon after disappearance, and from the meteor passing beneath a cloud, and from black fragments being noticed to fall, it is probable that the noise heard here was from the first explosion (when nearest over head, this would give an altitude of about 14,000 yards), and that other fragments fell elsewhere. The newspapers describe fragments s having been picked up in Hanover.—E. J. Lowe.

Second Report of the Committee, consisting of the Earl of ROSSE, *the* Rev. Dr. ROBINSON, *and* Professor PHILLIPS, *appointed by the General Committee at Belfast, to draw up a Report on the Physical Character of the Moon's Surface, as compared with that of the Earth.*

THE Committee have on this occasion to report that two of the eminent persons whose co-operation they had the good fortune to secure, Professor Challis and Professor P. Smyth, have sent in communications and drawings, according to the request of the Committee, and that some steps have been taken by one of their own members for at least putting in train for further progress the photographic experiments on the moon, of which some preliminary notice was delivered to the Hull Meeting. The new communications alluded to will be presented to the Section at this Meeting.

(On behalf of the Committee) JOHN PHILLIPS.

"*Drawings of different Features of a portion of the Moon's Surface, comprising Plato, the Alps, the Valley of the Alps, and Cassini.*

"Cambridge Observatory, September 18, 1854.

"These drawings were made under my direction by my senior assistant, Mr. Breen, with the Northumberland Telescope of the Cambridge Observatory. They were all sketched at sight, and were taken at various ages of the moon for the purpose of obtaining indications of the forms and configuration, both *in plano* and in relief, of the different parts of the portion of the moon's surface which has been allotted to me for mapping. They are, therefore, only to be considered as preparatory and auxiliary to a final delineation. A few micrometer measures accompany them. It is proposed hereafter to multiply the micrometer measures for the purpose of correcting the drawings, and connecting them together, and for reducing all to the same scale. On and after September 1, 1854, Mr. Breen made use of a shade of glass slightly green, the effect of which is to take off the glare of strong moonlight, and to produce a tint by which the distinction between the lighter and darker shades on the moon's surface is more perceptible. To my eyes the greenness of the shade soon vanishes, and the eventual tint is a subdued white. [On removing the green glass and looking at the moon's surface, the complementary pink colour is strongly developed.] All the necessary explanations are given on the cards upon which the drawings are made, and in the notes attached to them. "JAMES CHALLIS."

"*Interim Report on the 'Mare Crisium and its Shores.'*"

By Professor C. PIAZZI SMYTH.

"September, 1854.

"Three large drawings of this lunar region are transmitted herewith, exhibiting it under the three different phases of incident light recommended by the Lunar Committee of the British Association. They are likewise reduced to a mean state of libration, and are on a scale of 98 inches to the diameter of the body.

"Ten original sketches made at the telescope, and on which the above compositions have been framed, are also sent, with notes and explanations, as well as a skeleton map for identification of features and places.

"The magnifying power employed, which was the highest possessed, and unfortunately too much for the indifferent quality of the object-glass, was about 200. But experience has shown that the power of not less than 1000, as recommended by the Committee, with suitable size and quality of object-glass, would have been in the highest degree advantageous.

"Practice and experience brought to view so many decided and interesting features of *colour*, that the monochrome proposed was exchanged for the usual landscape box of colours, ground up first with water, but afterwards with oil, the latter mode appearing preferable, as white had as often to be put in on black, as black on white.

"Situated so close as the Mare Crisium is to the limb of the moon, the effects of libration were found so extensive in altering the perspective, and the consequent apparent form of mountains, as well as the shade of slopes for any constant age of the moon, that special measures had to be taken to correct for it.

"So extensive a surface as that proposed to me, viz. the 'Mare Crisium and its shores,' can hardly be done justice to by only one drawing in each of the prescribed incident lights; for when one boundary is exhibiting the lights and shadows of elevation and depression in the most instructive manner, the opposite boundary is then beginning to show those physical and often very diverse phænomena which are brought out by a vertical illumination.

"After the greater number of the sketches had been obtained, and not till then, Beer and Mädler's map was referred to. The result then went to show its exceeding great accuracy and admirable completeness in topographical particulars, expressed in a certain conventional style; but it failed in giving the physical and mechanical features, as they are seen in the telescope, as they exist in nature, and in the form they are required to be seen in for the purpose of enabling any geological speculations to be safely indulged in.

"Indeed it is radically impossible for any *one* map to give all the features; for the shading which is introduced to express the depth of a crater, and its blackness at the new or old moon, is at once and directly opposed to the indication of the excessive whiteness of its internal walls, as revealed at the full moon.

"In the drawings now presented exactly such a case is offered by the crater Proclus, whose walls, by the way, are *not* broken through towards the north, as shown in the German map.

"Equally difficult is it on any *one* map, and that on a small scale, to exhibit how completely the monster craters of Macrobius and Cleomedes, with the high conical mountains N. and S. of Proclus, and the cliffy and vertically stratified ranges on the N.W. border of the Mare, disappear under a vertical illumination,—while then come forth the bright radial markings of Proclus, and a large and bright inroad into the Mare, completely altering its contour at that part. Moreover, the crater of Proclus, with its internal walls so brilliant and so sharply defined, then becomes the prominent object of all that region, though with the side light it is least so. Hence Russell's idea with his Lunar Maps, of keeping one sheet for the phænomena of a vertical light, and another for those of the side light, was good in principle; but the small scale he adopted, and the imperfect execution, render his plates useless for researches in the present day.

"In conclusion, I have only to add, that of the large drawings,—

No. 1	shows the Mare Crisium at		New Moon;
No. 2	„	„	Full Moon, or a little before, to show vertical illumination;
No. 3	„	„	Old Moon;

and that in all of them most attention has been given to the N.W. region, and the craters there adjacent, while little or nothing has been attempted in the region between the Mare and the moon's limb.

"C. P. S."

On the Application of Water-pressure Machinery.
By W. G. Armstrong, *F.R.S.*

[A communication ordered to be printed among the Reports.]

The employment of water pressure as a mechanical agent having recently undergone a great and rapid development, I may be permitted to make a few observations on the successive steps by which its present importance has been attained. In so doing I shall commence with the year 1846, in which, after many preliminary experiments, I succeeded in establishing upon the public quay at Newcastle-upon-Tyne, the hydraulic crane which has formed the basis of what has since been effected.

This crane both lifted the weight and swung round in either direction by the pressure of water, and was characterized, like all other hydraulic cranes since made, by remarkable precision and softness of movement, combined with great rapidity of action.

The experiment thus made at Newcastle having proved satisfactory, I soon afterwards obtained authority, through the intervention of Mr. Hartley, the Dock Surveyor of Liverpool, to construct several cranes and hoists upon the same principle at the Albert Dock in that town, where they were accordingly erected, and have ever since continued in operation.

The next place at which these cranes were adopted was Grimsby New Dock, where an important step in the advancement of this kind of machinery was made on the suggestion of Mr. Rendel, who pointed out its applicability to the opening and closing of dock gates and sluices, and instructed me to extend its application to those objects. An extensive system of water-pressure machinery was accordingly carried out at that dock, and the result afforded the first practical demonstration that the pressure of a column of water could be advantageously applied as a substitute for manual labour, not merely for the cranage of goods, but also to give safe and rapid effect to those mechanical operations which are necessary for passing ships through the entrances of docks.

In all these instances the moving column of water was about 200 feet in elevation. At Newcastle and Liverpool the supply was derived from the pipes communicating with the town reservoirs, but at Grimsby a tower was built for supporting a tank into which water was pumped by a steam-engine. In the former cases, the fluctuation of pressure, consequent upon the variable draught from the pipes for the ordinary purposes of consumption, proved a serious disadvantage; but this objection had no existence at Grimsby, where the tank upon the tower furnished a separate source of power, undisturbed by any interfering conditions. Nothing could be more effectual for its purpose than this tower; but, in the natural course of improvement, I was subsequently led to the adoption of another form of artificial head, which possessed the advantage of being applicable, at a comparatively small cost, in all situations, and of lessening the size of the pipes and hydraulic machinery, by affording a pressure of greatly increased intensity.

The apparatus thus substituted for a water tower I named "*the Accumulator*," from the circumstance of its accumulating the power exerted by the engine in charging it. The accumulator is, in fact, a reservoir giving pressure by *load* instead of by *elevation*, and its use, like that of every provision of this kind, is to equalize the strain upon the engine in cases where the quantity of power to be supplied is subject to great and sudden fluctuations.

The construction of the accumulator is exhibited in Plate I. fig. 1, and needs but little explanation. It consists of a large cast-iron cylinder, fitted with a plunger, from which a loaded weight case is suspended, to give pressure to the water injected by the engine. The load upon the plunger is usually such as to produce a pressure in the cylinder equal to a column of 1500 feet in elevation, and the apparatus is made sufficiently capacious to contain the largest quantity of water which can be drawn from it at once by the simultaneous action of all the hydraulic machines with which it is connected. Whenever the engine pumps more water into the accumulator than passes direct to the hydraulic machines, the loaded plunger rises and makes room in the cylinder for the surplus; but when, on the other hand, the supply from the engine is less, for the moment, than the quantity required, the plunger, with its load, descends and makes up the deficiency out of store.

The accumulator also serves as a regulator to the engine; for when the loaded plunger rises to a certain height, it begins to close a throttle valve in the steam-pipe, so as gradually to reduce the speed of the engine until the descent of the plunger again calls for an increased production of power.

The introduction of the accumulator, which took place in the year 1851, gave a great impulse to the extension of water-pressure machinery, which is now either already applied, or in course of being applied, to the purpose of cranage throughout all the great dock establishments in London, as also to a considerable extent in Liverpool and other places. I have also applied it extensively to railway purposes, chiefly under the direction of Mr. Brunel, who has found a multitude of cases, involving lifting or tractive power, in which it may be made available. Most of these applications are well exemplified at the new station of the Great Western Railway Company in London, where the loading and unloading of trucks, the hoisting into warehouses, the lifting of loaded trucks from one level to another, the moving of turn-tables, and the hauling of trucks and traversing machines are all performed, or about to be so, by means of hydraulic pressure supplied by one central steam-engine with connected accumulators. Mr. Rendel also, after having successfully adopted the low-pressure system to the working of the gates and shuttles at Grimsby, has since applied the high-pressure, or accumulator system, to the same purposes at other new docks, and a similar adaptation is being made by other eminent engineers at most of the new docks now in course of construction.

I have also adapted hydraulic machinery to the opening and closing of swing-bridges and draw-bridges of large dimensions; and, in fact, there is scarcely any mechanical operation to which human labour has been hitherto applied as a mere moving power, which may not be efficiently performed by means of water-pressure emanating from a steam-engine and accumulator. Even if hand-labour be retained as the source of the power, the intervention of an accumulator will in many cases both economise labour and increase despatch. For example, a pair of heavy dock-gates requires the constant attendance of a considerable number of men whose labour is only called into action occasionally, viz. when the gates are being opened or closed. Now, if an accumulator, charged by hand-pumps, were used, the labour employed would be constant, instead of occasional, and the power collected in the accumulator by the continuous process of pumping would be given out in a concentrated form, and thus the ultimate result would be effected with fewer hands and greater despatch than where manual labour is directly applied.

The form of pumping-engine which I generally use for charging the accumulator is represented in Plate II. fig. 2. It consists of a horizontal steam-cylinder, with two force-pumps connected directly with the piston. These force-pumps are supplied with water from a cistern over the engine-room, into which the water discharged by the cranes is generally brought back by a return-pipe, so that the water is not wasted, but remains continuously in use.

With a pressure representing a column of 1500 feet, the loss of head by friction in the pipes forms so small a deduction from the entire column as to be a matter of no consideration, and consequently the distance at which the engine may be situated from the points where the hydraulic machines may be placed is of little importance, except as regards the cost of the pipe. It is advisable, however, if the pipe be very long, to apply an accumulator at each extremity, so as to charge the pipe from both ends.

With regard to the mechanism of hydraulic cranes, the arrangement which I first adopted, and have ever since adhered to, consists of one or more hydraulic presses, with a set of sheaves, used in the inverted order of blocks and pulleys, for the purpose of obtaining an extended motion in the chain from a comparatively short stroke of the piston. This construction, which characterizes nearly all the varieties of the hoisting and hauling machines to which I have applied hydraulic pressure, is exhibited in Plate III. fig. 3, which represents one of these presses with sheaves attached, to multiply the motion fourfold. In cases where the resistance to be overcome varies very considerably, I generally employ three such cylinders, with rams or pistons acting either separately or conjointly upon the same set of multiplying sheaves, according to the amount of power required.

In hydraulic cranes the power is applied, not only for lifting the load, but also for swinging the jib, which latter object is effected by means of a rack or chain operating on the base of the moveable part of the crane, and connected either with a cylinder and piston having alternate motion, like that of a steam-engine, or with two presses applied to produce the same effect by alternate action.

The absence of any sensible elasticity in water renders the motions resulting from its pressure capable of the most perfect control, by means of the valves which regulate the inlet and outlet passages of the machines; but this very property, which gives so much certainty of action, tends to cause shocks and strains to the machinery, by resisting the momentum acquired by the moving parts. Take, for example, the case of an hydraulic crane swinging round with a load suspended on the jib, the motion being produced by the water entering on one side of a piston and escaping from the other. Under such circumstances, if the water passages be suddenly closed by the regulating valve, it is obvious that the piston, impelled forward by the momentum of the loaded jib, but met by an unyielding body of water deprived of outlet, would be brought to rest so abruptly, as to cause, in all probability, the breakage of the machine. So, also, in lowering a heavy weight with considerable velocity, if the escape-passage be too suddenly closed, a similar risk of injury would arise from the abrupt stoppage of the weight, if a remedy were not provided; but these liabilities are effectually removed by applying, in connexion with the water passages to the cylinder, a small clack-valve, opening upwards against the pressure into the supply pipe, so as to permit the pent-up water in the cylinder to be pressed back into the pipe whenever it becomes exposed to a compressive force exceeding the pressure on the accumulator. By this means all jerks and concussions are avoided, and a perfect control over the movement of the machine is combined with great softness of action.

With regard to the kind of valves used for water-pressure machines, I find that either lift-valves or slide-valves may be effectually applied, and kept tight under heavy pressures, provided that sand be excluded from the water, and the valves be made of proper material.

In cases where a more prolonged movement is required than multiplying sheaves will conveniently afford, I employ rotative machines of various constructions. For heavy pressures, such as an accumulator affords, an arrangement, consisting of three plungers, connected with a triple crank, and bearing a general resemblance to a three-throw plunger pump, is well adapted for the purpose. The admission and exhaust valves are mitred spindles, pressed down by weights and levers, and lifted in proper rotation by cams fixed for that purpose upon a separate shaft, and these valves are associated with relief-clacks, to obviate the concussion which would otherwise be liable to take place at the turn of each stroke.

The liability of water-pressure machinery to be deranged by frost has often been adduced as an objection to its use; and upon this point I may observe—first, that I have never experienced any interference from this cause when the machines were placed, as they generally are, beneath the surface of the ground, or within a building; and secondly, that when they are unavoidably exposed, all risk may be prevented by letting out the water in frosty weather whenever the machines cease working.

When the moving power consists of a natural column of water, the pressure rarely exceeds 250 or 300 feet, and in such cases I have employed for rotative action a pair of cylinders and pistons, with slide-valves, resembling in some degree those of a high-pressure engine, but having relief-valves, to prevent shock at the turn of the stroke. Plate III. fig. 4 shows a slide-valve adapted for the turning apparatus of a crane, but the relief-clacks of which are equally applicable to a water-pressure engine of the construction in question. Two of these clacks open against the pressure in the supply-pipe, so as to afford an escape for the water, which would otherwise be shut up in the cylinder when the exhaust port closes, and the other two communicate with the discharge-pipe, so as to draw in a portion of waste water to fill up the small vacancy which would otherwise be left in the cylinder on the closing of the admission port. About four years ago I constructed four hydraulic engines upon this principle at Mr. Beaumont's lead mines in Northumberland, at the instance of Mr. Sopwith, Mr. Beaumont's well-known agent, and two more have recently been added at the same place. They are used for crushing ore, for hoisting materials from the mines, for pumping water, and for driving a circular saw and other machinery.

If in progress of time railways should be generally extended into mountainous districts, so as to render them accessible for manufacturing purposes, the rapid streams which abound in such localities will probably become valuable sources of motive power, and a wider field may then be afforded for the application of water-pressure engines to natural falls.

The object, however, which I have chiefly had in view since I first gave attention to this subject, has been to provide, in substitution of manual labour, a method of working a multiplicity of machines, intermittent in their action, and extending over a large area, by means of transmitted power produced by a steam-engine and accumulated at one central point. The common mode of communicating power by shafting could only be applied in cases where the machines were collected within a small compass, and where the accumulation of power necessary to meet varying resistance did not exceed that which a fly-wheel would afford. Compressed or exhausted air was almost equally inapplicable to the purposes I contemplated, in consequence of the many objections which its elasticity involves, as well as the liability to leakage, which, in an extended system of pipes and machines, requiring a multitude of joints, valves, and fitting surfaces, would form an insurmountable difficulty. But the use of water as a medium of transmission is free from all these objections, and its fitness for the purpose intended is now thoroughly established by the results which have been obtained.

The most recent specimen to be seen in Liverpool of water-pressure machinery, as applied to cranage and hoisting purposes, is that which is now nearly completed at the Stanley Dock, where the magnificent warehouses lately finished, and in which this machinery is being fixed, will in themselves amply repay a visit of inspection.

On the Equivalency of Starch and Sugar in Food. *By* J. B. Lawes, *F.R.S., F.C.S.;* *and* J. H. Gilbert, *Ph.D., F.C.S.*

At the Meeting of the British Association held at Belfast, we gave a Paper "On the Composition of Foods in relation to Respiration and the Feeding of Animals," in which it was illustrated by reference to numerous experiments, that as our current food-stuffs go, it was the amounts they supplied of the digestible *non*-nitrogenous, rather than those of the nitrogenous constituents, which *cæteris paribus* measured both the quantity consumed by a given weight of animal within a given time, and the amount of increase obtained from a given weight of the dry substance of the food. It was demonstrated too by the results adduced, that much more *fat* might be stored up in the animal body than existed as fatty matter in the food consumed, and it seemed obvious that at any rate the chief source of this *produced* fat must be the starchy and saccharine rather than the nitrogenous constituents of the food. The investigation now to be recorded might therefore be considered as closely allied to, or rather in continuation of the former line of inquiry, the point particularly to be illustrated being, the comparative respiratory and fattening capacities of certain of the predominant non-nitrogenous constituents of our current vegetable foods; namely, as indicated by the title of our Paper, of *Starch* and *Sugar*, which enter so largely into the composition of such descriptions of food.

Starch undoubtedly constitutes by far the largest proportion of the digestible non-nitrogenous matter of the complex vegetable substances, such as the cereal grains, potatoes, &c., used as human food; and it abounds also largely in some articles of diet of the lower animals. *Sugar*, on the other hand, although existing to a much smaller extent than Starch in the naturally combined vegetable diet of Man, yet in one of its forms more especially, it constitutes an important item in his manufactured vegetable food—and in another, is a product in the course of transformation of Starch itself, not only in some of our methods of preparing starchy matters for the purposes of food, but also in the process of its assimilation by the animal economy. Sugar, moreover, occurs largely in the roots and bulbs which at certain periods of the year replace the more starchy vegetable products consumed by the animals of the farm at other seasons. And, it has frequently been urged, that it would be a great boon to the agricultural interest were a considerable portion of the starchy grains used as cattle food, converted by the malting process into a peculiar sugar previous to its being employed as food for stock. And again, those interested in the growth of cane-sugar have long desired to obtain the introduction of the lower qualities of that article *duty free, for feeding purposes*. In many points of view therefore, both scientific and economical, it seemed desirable to put to the test of actual experiment the comparative respiratory and feeding capacities of *Starch* and *Sugar*, which from the related chemical composition and characters of the substances coming under these heads, have hitherto, on theoretical grounds alone, been considered as equivalent.

The method adopted to this end was—profiting by the experience of past feeding experiments—to apportion to the animals under comparative trial, in several cases, such a *fixed* amount of highly nitrogenous food as should leave only the requirement for *non*-nitrogenous constituents in addition; which, either in the form of Starch, of Sugar, or both, was then allowed in any quantity the animals chose to eat them. In another case, the nitrogenous, the starchy, and the saccharine foods were each allowed *ad libitum*; so that by the results of the latter arrangement, a judgement could be formed of the sufficiency of the fixed apportionment in the other cases. The amount and composition of the respective foods consumed, and the weights of the animals at stated periods, form the data for our conclusions.

The animals selected for experiment were pigs; for, owing to the proportionally small amount of necessarily effete substance, such as woody fibre, in their appropriate food as compared with that of the grass and hay in extinct animals, the amount of the dry substance of the food taken represents much more nearly in their case the sum of that in the increase and the respiratory expenditure than in that of the latter. And owing to this circumstance, and to the comparatively rapid fattening tendency of these animals, they give a larger proportion of increase in relation to their weight and for a given amount of food-constituents consumed than any other animal of the farm. Though, even in the case of the pig, as has been proved by our previous experiments, more than 80 per cent. of the dry substance of the food is, so to speak, employed *functionally*, that is to say, is eliminated from the body, either in the exhalations by the lungs and skin, or in the solid and liquid excrements, only about 15 per cent. of the whole serving for the increase of the substance of the body. Though, as was also shown in our former paper, about twice that amount of starchy, saccharine and proteine matter will directly contribute to the formation of the fifteen parts of the mixed nitrogenous and *fatty* substance of the increase; it being the two former, namely the Starch and the Sugar, which chiefly minister to the fatty increase.

The detailed arrangement of the experiment was as follows:—Twelve pigs, carefully chosen for general uniformity as to weight and description, were allotted to four pens, three in each, in such manner, that, as far as possible, each animal should have its counterpart as to character in each of the other pens; and so also, that the total weight should be nearly the same in each pen. These objects were well attained in the allotments to pens 1, 2 and 3, the results of which were to be more closely compared; but in pen 4, the animals were somewhat larger in frame and of a more growing character. The following were the weights of the animals in each pen when thus allotted and put up for the experiment:—

TABLE I.—Weights of the Pigs when put up for experiment (lbs.).

Pig, No.	Pen 1.	Pen 2.	Pen 3.	Pen 4.
1	95	94	98	89
2	79	80	77	87
3	72	73	74	86
Total	246	247	249	262

After the allotment as above, each lot was fed for a week on its experimental food before commencing the exact experiment, in order to accustom the animals to their new foods and new situation.

The foods employed were:—

Lentils—as affording a somewhat concentrated supply of nitrogenous constituents.

Bran—as characteristically supplying, besides some nitrogenous starchy and fatty matter, a considerable proportion of *woody fibre*, which, in the case of our ruminant feeding animals, seems so essential to give *bulk* to the food.

Sugar—coarse brown Penang sugar.

Starch—the "potato-starch" of the market.

In the following Table (II.) is given a summary of the results of analysis of the foods; there having been always two determinations or more agreeing well together in each case.

TABLE II.—Summary of the per-centage composition of the Foods.

Description of food.	Dry matter.		Ash.		Nitrogen.	
	Inclusive of ash.	Exclusive of ash.	In fresh substance.	In dry substance.	In fresh substance.	In dry substance.
Lentil meal ...	87·32	83·04	4·280	4·901	4·201	4·811
Bran	84·12	78·35	5·768	6·856	2·301	2·737
Sugar	93·60	92·79	0·808	0·862	0·193	0·206
Starch	80·43	80·03	0·396	0·492	0·167	0·208

It is seen that the Sugar employed contained about 6½ per cent. of moisture, nearly 1 per cent. of mineral impurity, and nearly 0·2 per cent. of nitrogen, equal to rather more than 1 per cent. of nitrogenous proximate, if reckoned as proteine compound. The Starch, as has been said, was that sold as "potato-starch," and is seen to contain very nearly the same amount of nitrogen as the sugar, but due in its case to the nitrogenous cell-membrane. In the

Starch, however, there was nearly 20 per cent. of water, instead of only about 6½ per cent. as in the Sugar.

The next Table (III.) shows the daily allowance per head of each of the foods which were given in fixed quantity, and also the amounts consumed of those given *ad libitum*, during each fortnightly period of the experiment, which in all extended over ten weeks.

Table III.—Showing the daily allowance, or *ad libitum* consumption, per head, of each food during the five separate periods, and the total period of the experiment.

[Quantities in lbs. and ozs.]

Pens.	Foods—how given.	1st 14 days.	2nd 14 days.	3rd 14 days.	4th 14 days.	5th 14 days.	Average, 10 weeks.
	Lentil Meal.						
1. 2. 3.	In fixed quantity......	3 0	3 0	3 0	3 8	3 8	3 3¼
4.	*Ad libitum*	4 6¾	2 10	4 4½	4 13	5 11½	4 6
	Bran.						
1. 2. 3.	In fixed quantity......	1 0	1 0	0 8	0 4	0 4	0 9½
4.	*Ad libitum*	0 6¾	0 4½	0 2½	0 2¼	0 1½	0 3½
	Sugar and Starch.						
1.	*Ad libitum*, Sugar	1 7½	1 10¼	2 1½	2 2¼	1 14½	1 13½
2.	,, Starch ...	1 10½	1 10¼	2 2¼	2 9	2 11½	2 2¼
3.	,, Sugar	0 14	1 5	1 5	1 11	1 6¾	1 5¾
	Starch......	0 13¾	1 1½	1 10	1 14½	1 7½	1 6¼
	Total	1 11¾	2 6½	2 15	3 9½	2 14¼	2 12
4.	,, Sugar	1 4½	2 9½	2 2½	2 6	2 3	2 2
	Starch......	0 4	0 3¾	0 3¾	0 4½	0 3	0 3¾
	Total	1 8½	2 13¼	2 6¼	2 10½	2 6	2 5¾

In pens 1, 2, and 3, then, there was throughout the experiment a fixed and equal daily allowance per head of the lentil-meal and bran respectively. In addition to these, the pigs in pen 1 had as much Sugar, those in pen 2 as much Starch, and those in pen 3 as much, both of Sugar and Starch, as they chose to eat. In pen 4, on the other hand, lentil-meal, bran, sugar and starch were each given in a separate trough, and *ad libitum*; from the consumption in this pen 4, therefore, the natural inclination of the animals for the different foods could be judged of. At the commencement, the allowance of lentil-meal in pens 1, 2, and 3 was 3 lbs. per head per day; this amount being indicated by previous experiments, as about that which would, with the bran to be added, afford a due supply of the nitrogenous constituents of food. It was at once seen that the pigs in pen 4, which fixed their own consumption of the respective foods, took considerably more of the nitrogenous lentil-meal than the fixed allowance of the other pens; and after the third period, that is, at the end of six weeks, the fixed allowance of lentil-meal in pens 1, 2, and 3 was increased from 3 lbs. to 3½ lbs. per head per day. In like manner, 1 lb. of bran per head per day was at first given in the pens 1, 2, and 3; but this, on the other hand, was much more than was taken of it by the pigs in pen 4. The fixed daily ration of bran per head was therefore, after the second period, reduced from 1 lb. to ½ lb., and, during the fourth and fifth periods, to ¼ lb. per head per day. Still even this amount of bran was considerably more than that taken at will in pen 4. But one object of the experiment was to give a pretty full allowance of the cheaper and less nutritious bran, in order to see whether, when mixed with pure digestible proximate principles, such as Sugar and Starch, somewhat more of it could, without disadvantage, be employed.

In pen 1, where, in addition to the fixed allowance of lentils and bran, a trough was kept constantly supplied with *Sugar*, it is seen that during the first four periods there was a gradual increase in the quantity of it consumed,—the average consumption for the whole ten weeks being nearly 2 lbs. of Sugar per pig per day. This purely non-nitrogenous substance constituted in fact about one-third of the total food of the animals,—a range of amount, or proportion of the whole consumption, sufficiently great to justify a judgement by comparison with that of the Starch, of the relative capacities of the two substances to meet the complex demands of the system of a fattening animal.

In pen 2, *Starch* was given as the purely non-nitrogenous and *ad libitum* food; and the average consumption of it over the whole period of ten weeks was rather more than 2 lbs. 2 oz. per head per day. More, therefore, was consumed of the Starch than of the Sugar; but it will presently be seen that the amounts of the *dry substance* of the foods was almost identical in the two cases, and that therefore the apparently larger consumption of Starch was simply dependent on its containing more of water than the Sugar.

In pen 3, in which there was the same fixed allowance of lentils and bran as in pens 1 and 2, the complementary food consisted of both Sugar and Starch. Of these two, taken together, the average daily consumption per head amounted to about 2¾ lbs. Considerably more, therefore, was eaten of the mixture than of either the Sugar or the Starch when given alone. The effect on the appetite of the animal of a certain complexity of diet, even in the case of substances having in one sense equal food capacities, is therefore here illustrated; though, owing probably to a somewhat defective proportion of nitrogenous compounds in the total food of this pen 3, we have not in this case, as will presently be seen, the advantage of this increased consumption in a correspondingly greater proportion of increase to the dry substance of the food consumed.

In pen 4, where the lentil-meal, the bran, the sugar, and the starch were each put into a separate trough, considerably more of the highly nitrogenous lentil-meal was eaten than in any of the other cases. And it is remarkable, that with this larger consumption of lentils, scarcely any free Starch is taken, but of the Sugar more even than in pen 1, where no free Starch was allowed, but only the Sugar as the *ad libitum* food. This might be accounted for by supposing that the pigs in pen 4 had a larger and sufficient supply of starch in the larger quantity of lentils taken, and that therefore the system called for the sugar rather than the addition of starch in the free state; and this would be to attribute the result to a physiological requirement, apart from that of the palate or stomach merely. It is, however, much more likely that it was simply a matter of palate and stomach; for in pen 3, where also both

Sugar and Starch were given, a certain portion of each was mixed with the limited food, so that all except the free Starch being saccharine, the greater would be the relish for it, and hence we have much more of Starch consumed in pen 3 than in pen 4.

But there is another point that should be noticed before leaving the question of the dieting of the animals. In a previous experiment with pigs, in which some of them which were fed on food comparatively defective in mineral matter suffered considerably in health, a mixture of coal and wood ashes, superphosphate of lime and common salt was given with the best effects. It was thought, therefore, that in this case, in which lentils, sugar, and starch were all somewhat deficient, particularly in phosphates, a similar mixture might be useful. Accordingly a mixture of 20 lbs. of the ashes, 2½ lbs. superphosphate of lime, and 2½ lbs. of common salt were divided into four parts, and one of the fourths given to each pen, this amount being distributed over fourteen days. This mineral mixture was always taken with the greatest avidity and relish; so much so, that the animals would leave their other troughs the moment the fresh supply of this was put within their reach. They were, moreover, upon the whole, very healthy throughout the experiment, and yielded good rates of increase.

In the next Table (IV.) is shown the per-centage proportion to the total food, in which each of the separate articles was consumed during the successive periods as the experiment progressed.

TABLE IV.—Per-centage proportion of each food in the total food during each successive period, and the total period of the experiment.

Pens.	Foods—how given.	1st 14 days.	2nd 14 days.	3rd 14 days.	4th 14 days.	5th 14 days.	Average, 10 weeks.
	Lentil Meal.						
1.	In fixed quantity	54·90	53·16	53·62	59·39	61·89	56·63
2.	,, ,, ...	53·05	53·16	53·16	55·37	54·14	53·82
3.	,, ,, ...	52·17	46·84	45·32	47·65	52·59.	48·82
4.	*Ad libitum*...............	69·14	45·64	62·50	63·12	69·77	62·79
	Bran.						
1.	In fixed quantity	18·30	17·72	8·94	4·24	4·42	10·62
2.	,, ,, ...	17·68	17·72	8·86	3·95	3·87	10·09
3.	,, ,, ...	17·39	15·61	7·55	3·41	3·76	9·15
4.	*Ad libitum*..............	6·69	4·98	2·43	1·87	1·16	3·21
	Sugar and Starch.						
1.	*Ad libitum*, Sugar......	26·79	29·11	37·45	36·36	33·68	32·74
2.	,, Starch ...	29·26	29·11	37·97	40·68	41·99	36·08
3.	,, { Sugar	15·42	20·44	22·66	23·01	21·46	20·79
	Starch......	15·01	17·10	24·46	25·93	22·18	21·23
	Total	30·43	375·4	47·12	48·94	43·64	42·02
4.	,, { Sugar	20·07	45·23	31·60	31·25	26·74	30·51
	Starch......	4·09	4·15	3·47	3·75	2·33	3·49
	Total	24·16	49·38	35·07	35·00	29·07	34·00

Turning first to pen 4, in which all the foods were taken separately and at will, it is seen that the highly nitrogenous lentils constituted a considerably larger proportion of the total food in this pen than in either of the others. The animals first began, *pig-like*, with an excessive quantity, which seems to have amounted for the time to a surfeit; for in the second period they do not take two-thirds as much as in the first, though afterwards they gradually increase to the original amount, but taking then considerably less of the also highly nitrogenous bran than at the commencement. In this pen 4, indeed, the consumption of *bran* is at the commencement only about one-third as great as in the other pens, and it gradually reduces as the experiment proceeds, until at last it amounts to little more than 1 oz. per head per day. Although, therefore, so much more of the nitrogenous lentils is consumed in pen 4 than in either of the others, yet it will afterwards be seen, that, taking the lentils and bran together, the proportion of total nitrogenous constituents in the food of pens 1 and 2, especially, is not so much less than in pen 4 as would at first sight be assumed from the larger consumption of lentils in the latter; and it may be observed that this proportion of nitrogenous compounds was in all the other cases still notably higher than in the cereal grains.

With regard to the more general indications of this Table (IV.), it may be remarked, that in former experiments, where fattening animals have been allowed high and low nitrogenous foods separately and at their own discretion, there has been a very marked increase in the proportion of the *non*-nitrogenous constituents consumed as the animals matured. This is not so obvious in the present instance; but in this case the foods were not of an ordinary kind, and were such as to give more scope for the exercise of the instinct of the palate. The result is that those animals which were allowed their own choice of all the foods, took first an excessive amount of the lentils, and then going to the other extreme, of the Sugar; so that, with this incidental and more than usual interference of the palate with a naturally greedy animal, we have the mere progress of the respiratory requirement and fat-forming tendency of the animals less clearly indicated in the selection of their food according to its ultimate composition.

In Table V. we have the amount of gross food consumed per 100 lbs. live-weight of animal per week during each of the successive periods, and the total period of the experiment; also the amount of gross increase obtained by the consumption of 100 lbs. of food during the same periods.

TABLE V.—Showing the rate of the consumption of food, and of the production of increase in weight, during the successive periods of the experiment.

Pens.	Description of the foods.		Average weekly consumption of total food, per 100 lbs. live-weight of animal.					
	In fixed quantity.	*Ad libitum.*	1st period. 14 days.	2nd period. 14 days.	3rd period. 14 days.	4th period. 14 days.	5th period. 14 days.	Average of total period.
1.	Lentils... Bran.....	Sugar ...	36·2	31·8	27·9	26·6	23·2	29·0
2.	Lentils... Bran......	Starch ...	37·6	31·9	28·4	28·5	26·5	30·5
3.	Lentils... Bran......	Sugar ... Starch ...	38·8	36·5	32·9	32·5	26·5	33·0
4.	None	Lentils... Bran ... Sugar ... Starch ...	41·3	31·8	33·1	31·9	30·2	32·6
		Means........	38·5	33·0	30·6	29·9	26·6	31·3

Table (continued).

Pens.	Description of the foods.		Gross increase obtained by the consumption of 100 lbs. of total food.					
	In fixed quantity.	*Ad libitum.*	1st period. 14 days.	2nd period. 14 days.	3rd period. 14 days.	4th period. 14 days.	5th period. 14 days.	Average of total period.
1.	Lentils... Bran......	Sugar ...	26·6	21·9	18·3	19·0	18·5	20·8
2.	Lentils... Bran......	Starch ...	26·1	20·7	17·3	21·1	14·7	19·9
3.	Lentils... Bran......	Sugar ... Starch ...	24·8	20·1	19·8	16·2	19·0	19·8
4.	None	Lentils... Bran ... Sugar ... Starch...	25·3	15·8	25·3	19·4	20·6	21·3
		Means.........	25·7	19·6	20·2	18·9	18·2	20·4

Although it has already been seen that a larger amount of food was consumed *per head* as the pigs increased in weight and fatness, yet it is shown in Table V. that there was a gradual decrease in the quantity consumed *per* 100 *lbs. live-weight of animal*, in all cases from the 1st period to the 5th. In fact, during the short space of five fortnightly periods, the amount of food consumed in proportion to the weights of the animals is pretty uniformly in the four pens about one-third less in the fifth period than in the first. With this decrease in the consumption of food in relation to weight, there is at the same time, as shown in the 2nd division of the table, a considerable decrease in the *amount of gross increase yielded by a given weight of food* as the fattening process progresses. Former experiments have however shown, that as the animal matures, its increase is much less aqueous; so that much of the lessened productiveness of the food in gross increase is only apparent so far as real dry substance of growth is concerned. Indeed, a careful consideration of the results of the Table, taken in connexion with other known facts, leads to the conclusion that the functional expenditure of constituents, so to speak, that is to say, the amount of them required to keep in action the machine of life, though not so great in proportion to the weight of the animal as it matures, yet continues pretty equally so in proportion to the amount of food consumed. On the other hand, the increase attributable to the remainder, or that portion of the food not so expended, though it may be less in *gross* amount than in the earlier stages of feeding, is probably about equal so far as the storing up of *real dry substance* is concerned. In fact, as the fattening proceeds, less *gross* weight of increase is obtained for a given amount of food; but the quality or food-capacity in its turn of that increase, is in a corresponding degree the greater. To fatten therefore beyond the point at which a higher price is obtained for a given weight of meat, is an advantage to the consumer, and not to the producer of it.

In the next Table (VI.) are given the total amounts of each of the fresh foods separately, and the collective foods, and of the dry organic matter, the mineral matter, and the nitrogen, contained in them, which were consumed in each pen during the ten weeks of the experiment. There is also given in the last column of the Table the amount of gross increase yielded in each pen.

Table VI.—Showing the total amounts of fresh foods, and constituents consumed, and of increase obtained, during the total period of the experiment.

[Quantities in lbs. and tenths.]

Pens.	Foods—how given.	Gross or fresh food.	Dry organic matter.	Mineral matter.	Nitrogen.	Increase.
	Lentil Meal.					
1. 2. 3.	Fixed quantity—each	672	558	28·8	28·2	
4.	*Ad libitum*	918	762	39·3	38·6	
	Bran.					
1. 2. 3.	Fixed quantity—each	126	99	7·1	2·9	
4.	*Ad libitum*	47	37	2·7	1·1	
	Sugar or Starch.					
1.	*Ad libitum*, Sugar	388½	360½	3·1	0·7	
2.	„ Starch	450½	360½	1·8	0·7	
3.	„ Sugar	286¼	265½	2·3	0·5	
	Starch	292¼	234	1·2	0 5	
	Total	578½	499½	3·5	1·0	
4.	„ Sugar	446	414	3·6	0·9	
	Starch	51	41	0·2	0·1	
	Total	497	455	3·8	1·0	
	Summary.—Total Food or Increase.					
1.	Lentils, Bran and Sugar	1186½	1017½	39·0	31·9	247
2.	„ „ and Starch	1248½	1017½	37·6	31·9	248
3.	„ „ Sugar and Starch	1376½	1156½	39·3	32·2	272
4.	„ „ „ „	1462	1254	45·8	40·6	312

It is a sufficiently remarkable fact, in relation to the main object of this investigation, namely the question of the equivalency of Starch and Sugar in food, that with three pigs in each case, the experiment extending over ten weeks, and the *ad libitum* Starch or Sugar constituting one-third of the total food, we should have in pens 1 and 2, in the former with Sugar, and in the latter with Starch, absolutely identical amounts of *dry organic substance* consumed in the two cases; and also, within one pound, exactly the same amount of gross increase in weight yielded by it. It thus appears, that whether for the purpose of supporting the functional actions of the body, or of ministering to the formation of increase,—for, as will be seen, the rate of increase was in both cases good,—these two substances have, weight for weight, values almost absolutely identical. But this point will be better seen in the Tables which next follow, in which are given, not the *actual* amounts of food or constituents consumed, and of increase obtained, but the amounts of food and constituents consumed *per* 100 *lbs. live weight*, and the amounts of each which were required *to produce* 100 *lbs. of increase*; and the items which are given in each case are—the fresh substance; the gross dry matter; the dry organic matter; the non-nitrogenous substance; the nitrogenous (proteine) compounds; the nitrogen and the mineral matter, the latter including only the amounts contained in the respective foods, and excluding therefore that given in the purely mineral mixture.

TABLE VII.—Showing the average amount of total food or constituents consumed, *per* 100 *lbs. live-weight per week*.

[Quantities in lbs., tenths, &c.]

Pens.	Description of the foods.		Fresh food.	Gross dry matter.	Dry organic matter.	*Non*-nitrogenous substance.	Nitrogenous substance.	Nitrogen.	Mineral matter.
	In fixed quantity.	*Ad libitum.*							
1.	Lentils ...... Bran..........	Sugar	29·0	25·8	24·84	19·93	4·89	0·78	0·96
2.	Lentils ...... Bran..........	Starch	30·5	25·7	24·86	19·96	4·90	0·78	0·92
3.	Lentils ...... Bran..........	Sugar Starch ...	33·0	28·6	27·72	22·68	4·85	0·77	0·94
4.	None	Lentils Bran Sugar Starch ...	32·5	29·0	28·08	22·38	5·70	0·902	1·024
		Means.........	31·2	27·3	26·38	21·29	5·09	0·81	0·96

Mean of 12 previous experiments.	29·5	25·9	24·84	19·15	5·69	0·90	1·12
,, 12 ,, ,, ...	32·7	27·9	26·80	20·65	6·15	0·97	1·09
,, 5 ,, ,, ...	32·6	27·0	25·27	19·86	5·42	0·87	1·66

We have then in Table VII. the average amounts over the whole period of the experiments, of the various constituents consumed weekly, per 100 lbs. live-weight of animal: and at the foot of the Table is given a summary of the same particulars in the cases of three previous series of experiments; in two of which there were 12, and in the third 5 pens. A comparison of the average of these former experiments, in which there was great diversity of fattening food, with that of the present series, sufficiently shows, both how uniform is the average rate of consumption of the dry substance of the food in relation to the weight of the animal when fed under somewhat similar circumstances, and also, that the results of the present series, with the food consisting to the amount of one-third of its weight of pure Starch or Sugar, are sufficiently normal in character to be trusted in their indications. And the same may be said in reference to the amount of increase yielded by a given weight of food, as shown by comparing the new results on this point given in Table VIII. with those of the previous ones in the summary at the foot of it.

TABLE VIII.—Showing the average amount of total food or constituents consumed, *to produce* 100 *lbs. of increase.*

[Quantities in lbs. and tenths.]

Pens.	Description of the foods.		Fresh food.	Gross dry matter.	Dry organic matter.	*Non*-nitrogenous substance.	Nitrogenous substance.	Nitrogen.	Mineral matter.
	In fixed quantity.	*Ad libitum.*							
1.	Lentils…… Bran………	Sugar ……	480	427	411·8	330·5	81·3	12·90	15·85
2.	Lentils…… Bran………	Starch ……	503	425	410·2	329·2	81·0	12·85	15·25
3.	Lentils…… Bran………	Sugar Starch …	506	439	425·1	350·6	74·5	11·82	14·51
4.	None ……	Lentils Bran Sugar Starch …	468	417	401·8	319·8	82·0	13·01	14·67
		Means………	489	427	412·2	332·5	79·7	12·65	15·07

Mean of 12 previous experiments.	583	511	488·3	376·3	111·9	17·77	23·20
„ 12 „ „ …	562	480	461·2	355·9	90·9	16·98	18·93
„ 5 „ „ …	554	458	429·7	336·6	93·1	15·01	28·77

Looking more closely to the figures in Table VII., it is seen, that, excepting in pen 4, the amount of nitrogen or nitrogenous constituents consumed per 100 lbs. live-weight per week was rather less than in the average of former experiments; it was however greater than in several of the individual cases of those former experiments, especially where the cereal grains constituted the chief bulk of the food, as has already been alluded to. In fact, although the amount of nitrogen consumed in pens 1, 2 and 3, was less than where the animals took as much of it as they chose to eat, yet even in these cases it was greater than in the very frequent fattening food of the pig; namely, barley-meal, in which however the proportion of nitrogen is rather under than over that which is most favourable for the increase of the fattening pig.

Again, in pen 2, with one-third of the total food Starch, about 1½ lb. more fresh food is consumed weekly per 100 lbs. live-weight of the animal than in pen 1, with one-third of it Sugar. But we find, that excluding the moisture in the foods, of which there was more in the Starch than the Sugar, the amounts of *dry organic substance* consumed are absolutely identical in the two cases. It is obvious, then, that the animals having in the two pens only about two-thirds as much material in their lentils and bran as the wants of the system called for, the further demand, amounting to one-half more, or one-third of the total food, was fulfilled in the respective cases by identical amounts of the dry substance of the Sugar and the Starch. These then are practically identical in their capacity of meeting the mixed wants of the animal body for non-nitrogenous substance. In pen 3, the weekly consumption of *non*-nitrogenous substance per 100 lbs. live-weight is rather greater than in pens 1 and 2; and it is probable that both Sugar and Starch being allowed in this pen, the greater variety of food increased the appetite. There was also with this greater consumption of *non*-nitrogenous substance more both of actual increase of animal, and of increase for a given weight of *nitrogenous* substance consumed, though somewhat less of it in proportion both to the *non*-nitrogenous substance and to the total dry organic substance of the food. It may likewise be said of pen 4, that with greater variety in the food, more was eaten in relation to the weight of the animal. But in this case there was more of the *nitrogenous* as well as of the non-nitrogenous constituents consumed; and with this larger and probably more normal proportion of the latter to the former, we have, as is seen in the next Table (VIII.), a better proportion of gross increase both to the non-nitrogenous substance, and to the total organic substance consumed.

But the amount of food consumed to a given weight of animal, as shown in Table VII., represents of course, not only the demands for the maintenance of the animal machine, that is, of the respiratory and collateral functions, but also those for the growth and permanent increase of the body. So also in Table VIII., the average amount of foods consumed for the production of 100 lbs. of increase includes also those required for the respiratory and other functional purposes. In our former Paper, however, read at Belfast, it was shown that in the case of a fattening pig then referred to, only about 15 per cent. of the dry substance of the food consumed were stored up in the animal as non-aqueous increase; about 85 per cent. of the total dry substance of the food of the animal being therefore expired, perspired, or voided. Although, however, so small a proportion of the food consumed may be actually stored up in the animal, still a comparison of the amounts of gross food or constituents consumed to produce a given weight of increase is doubtless of much importance as a measure of the relative feeding qualities of different articles of diet; and this is the point illustrated in Table VIII.

In this Table (VIII.), comparing first together the results of pens 1 and 2, we find that not only, as has been already seen, was the rate of consumption of the dry organic substance of the Starch and Sugar exactly identical in relation to the weight of the animal, but here it is found that the amounts required to yield a given increase in the weight of the body are also exactly identical; for 411¾ lbs. of total dry substance were required to produce 100 lbs. of increase when one-third of the food was Sugar, and 410¼ lbs. when one-third of it was Starch. The equivalency of the two would seem therefore to be clearly proved, both for the purpose of the maintenance of the system, and for that of the increase of the body of a fattening animal. Against the above quoted amounts of dry substance required in these cases to produce 100 lbs. of increase, it required 425 lbs. in pen 3, where the allowance of nitrogenous constituents was about the same as in pens 1 and 2, but the proportion of non-nitrogenous constituents eaten was rather greater; and only about 402 lbs. were required in pen 4, where the consumption of nitrogenous constituents was somewhat greater than in the other cases. Whilst therefore, as we have shown in other Papers, as our current food-stuffs go, it is frequently their *non*-nitrogenous rather than their nitrogenous constituents which measure their combined respiratory and feeding capacities, yet we have here usefully indicated, as also in other cases, the point below which a lessened amount of nitrogenous constituents is disadvantageous.

In conclusion, the evidence of direct experiment clearly goes to show, that all but identical amounts of the dry substance of Cane-Sugar and of Starch are both consumed by a given weight of animal within a given time, and are required to yield a given weight of increase. The practical identity in feeding value, which from the known chemical relationship of these two substances has hitherto been assumed, is now therefore experimentally illustrated, and it probably only varies in point of fact with their slightly varying per-centages of carbon.

If, then, Cane-Sugar has no higher feeding capacity than Starch, the relative prices weight for weight, of the sugar duty free, and of the starchy grains generally used for feeding purposes, will afford an easy means of estimating the probable economy of the use of the former. At the price, including duty, of the coarse Penang sugar used in the experiments, it would cost three or four times as much as the starchy cereal grains at the present time; and it should be remembered, that these would also supply a considerable amount of the needed nitrogenous constituents of food.

These new results too, so far as they can be supposed to apply with numerical accuracy, considering the difference between cane-sugar and the saccharine matter of malt, are consistent with direct experiments which we published some time since on the comparative feeding values of malted and unmalted grain. Thus it was shown, that the dry substance of malted and unmalted barley had very nearly equal respiratory and feeding capacities. But, not only is the process of malting attended with considerable expense, but it was shown in the experiments alluded to, that during the process there was a loss of 6 per cent. of the gross dry substance of the barley, and of 4 per cent. of its total nitrogen, even when the malt-dust was included as a product of the process, and supposed to be equally valuable as food; whilst, if the malt-dust were excluded, the loss for feeding purposes of the dry organic substance of the barley was 10 per cent., and that of its nitrogen 13½ per cent. It might be true, that malt and other saccharine matters might serve in some degree to give a relish to the food, and thus induce the animals to eat more, which in "fattening" is always a consideration; but this incidental benefit could not counterbalance much increased cost. Indeed the general result of experiment is contrary to the conclusion, that any extensive use of malt for feeding purposes would be such a boon as has been supposed.

The proved practical equivalency of Starch and Sugar in food is also of interest, as has already been alluded to, in reference to some other of the conclusions to which we have arrived in former papers. Thus it has been shown, that a fattening animal assimilates much less nitrogen than has usually been estimated; and further, that it may store up very considerably more fat than exists ready-formed in its food; whilst again this *produced* fat is doubtless in a great measure formed from the *starchy* and *saccharine* substances which constitute so large a proportion of the *non*-nitrogenous constituents of our staple vegetable foods. It is these *starchy* and *saccharine* substances too, which in practice serve largely to meet the requirements of the respiratory function—and this it has been shown it is, that under ordinary circumstances constitutes to such an extent, the measure of the amount of the food demanded by the animal system.

On the Deviations of the Compass in Wooden and Iron Ships.

By ARCHIBALD SMITH, *M.A.*

THE general character of the deviations of the compasses of a ship in northern latitudes is, that *the north end of the needle is drawn towards the ship's head.* But in many, and particularly in iron ships, the character of the deviations is different; in some the north end of the needle is drawn towards the stern, in others towards one side. These deviations change as the ship changes her magnetic latitude. In wooden ships they generally diminish as the ship approaches the magnetic equator, and change their direction when the ship has passed into a southern magnetic latitude. In iron ships the deviations generally diminish as the ship approaches the magnetic equator, but frequently, perhaps generally, increase again in southern latitudes, so as to retain the same direction in both hemispheres.

The cause of this difference, no doubt, is that in wooden ships the iron which affects the compass approximates to the condition which, in the language of magnetism, is called "soft iron," while in iron ships the rolled and hammered iron of which they are constructed approaches more nearly to the condition which is called "hard iron."

In both classes of vessels a great part of the magnetism approaches very nearly to that of "soft iron," being induced instantaneously by the magnetism of the earth, and changing instantaneously as the vessel is swung. In iron vessels, the magnetism which approaches to that of hard iron, is not, strictly speaking, permanent; it is what is called "sub-permanent" by the Astronomer Royal, and "retentive" by Dr. Scoresby. It is said by Dr. Scoresby to change when the vessel receives strains or shocks, and it generally changes to some extent when the vessel changes its magnetic latitude.

The general effect of masses of "soft iron" on the needle may be obtained with considerable accuracy by considering the action of pieces of iron of a very simple shape, viz. slender bars. A bar of soft iron held in the direction of the dip, or, as it is convenient to call it, the "line of force" of the earth, becomes instantly magnetic. Its south (in England, the upper) end attracts the north end of the needle; its north (in England, the lower end) attracts it. If the bar be inclined to the line of force, its magnetism diminishes, and when at right angles to the line of force, the bar ceases to be magnetic. If the inclination of the bar to the line of force be still further increased, the end which was north, and which then repelled the north end of the needle, becomes south and attracts it.

It follows from this, that if a bar of soft iron be in a vertical position, its upper end will in north magnetic latitudes attract the north end of the compass-needle. At the magnetic equator the line of force of the earth is horizontal, and there a vertical bar of soft iron will not be magnetic. In south magnetic latitudes the line of force of the earth is inclined upwards, and in those latitudes the upper end of a vertical bar of soft iron will repel the north end of the compass-needle, and attract the south end. The attraction of the upper end of such a bar of soft iron on the north end of the needle is in fact proportional to the total magnetic intensity multiplied by the *sine* of the magnetic inclination. The directive force of the earth on the needle being the antagonistic force which this attraction overcomes in producing a deviation, is proportional to the total intensity multiplied by the *cosine* of the inclination. The deviation produced will be as the ratio of these two forces, *i.e.* as the sine of the inclination to the cosine of the inclination, or proportional to the *tangent* of the inclination. Such a bar, placed in a ship with its upper end at the same level as the compass, will, as the ship is swung, produce no deviation when north or south of the compass, will produce a maximum easterly deviation when east, and a maximum westerly deviation when west of it, these bearings being always those by the disturbed compass.

If the bar of soft iron be horizontal, and in an east and west position, it is at right angles to the line of force, and will produce no effect; if it be horizontal and in any other position, its south end will attract the north end of the compass-needle. If such a bar be placed in a ship at the same level as the needle, and directed towards it, then in four positions as the ship is swung, viz. when the bar is E., W., N. or S. of the needle, it will produce no deviation; in the first two positions, because it is not magnetic; in the last two, because, though magnetic, it attracts the north end of the needle in the direction in which it already points. Such a bar will produce a maximum easterly deviation when N.E. or S.W. of the compass-needle, a maximum westerly deviation when S.E. or N.W. of it.

The attraction of such a horizontal bar on the needle when a change in the geographical position takes place, is proportional to the total magnetic intensity multiplied by the *cosine* of the inclination; the directive force of the earth on the needle, which it has to overcome in order to produce a deviation, is proportional to the same quantity. The deviation produced is consequently independent of the force and of the inclination, and is the same in all magnetic latitudes.

A bar of hard iron magnetized acts on the needle, when there is no change of magnetic latitude, precisely as a vertical bar of soft iron; that is to say, there are two opposite positions in which it causes no deviation, and two others, at distances from them of 90° by the disturbed compass, at which it causes maximum deviations, at the one easterly, at the other westerly.

There is, however, an important difference between the effect of a magnetized bar of hard iron and a vertical bar of soft iron when there is a change of magnetic latitude. The attraction of the bar of hard iron remains unchanged on a change of magnetic latitude; the directive force which it has to overcome in order to produce a deviation is proportional to the total magnetic intensity multiplied by the cosine of the inclination, or in other words, to the horizontal magnetic intensity. Hence the effect of a magnetized bar of hard iron in causing deviation is inversely proportional to the horizontal magnetic intensity at the place.

In all the cases which we have considered, as the ship is swung round, the amounts of easterly and of westerly deviations are exactly equal; but arrangements of bars of soft iron may easily be imagined in which one of these may predominate, and that to any extent.

Thus, if we suppose two similar and similarly placed horizontal bars of soft iron at the level of the compass, one lying N. and S. with its S. end E. of the compass, the other lying E. and W. with its E. end N. of the compass, these two bars will produce an easterly deviation, which, as the ship is swung, will remain sensibly constant.

Whatever be the shape and position of the iron in a ship, if it consists of iron of the two extreme qualities we have mentioned, if it is all at a considerable distance from the needle compared to the size of the needle, if the deviations are small, and if we suppose (as is done throughout) that the ship remains on even keel, the following formulæ for expressing the deviation of the needle in any azimuth may be deduced from Poisson's General Equations. See Col. Sabine's 'Contributions to Terrestrial Magnetism,' No. V. Phil. Tr. 1843, p. 147; No. VI. Phil. Tr. 1844, p. 117; and No. VIII. Phil. Tr. 1846, p. 347.

$$\begin{aligned}\delta = A &+ \left(B' \tan\theta + \frac{P'}{\phi\cos\theta}\right)\sin\zeta' \\ &+ \left(C' \tan\theta + \frac{Q'}{\phi\cos\theta}\right)\cos\zeta' \\ &+ D\sin 2\zeta' + E\cos 2\zeta',\end{aligned}$$

in which δ represents the deviation, considered positive when the north end of the compass-needle is drawn towards the east; θ the magnetic inclination; ϕ the total magnetic force; and ζ' the azimuth of the ship's head by the standard compass (disturbed), reckoned from N. to E.; and A, B, C, D, E are constants depending on the arrangement of the soft iron in the ship, and P′, Q′ constants depending partly on the soft and partly on the hard iron in the ship.

If we consider these terms separately, we see that A may arise from such an arrangement of horizontal bars as that last described, or from an index-error in the compass, or from an error in the shore compass.

$B' \tan\theta \sin\zeta'$, if B′ is positive, may arise from a vertical bar of soft iron placed before and below the compass, or abaft and above it.

$C' \tan\theta \cos\zeta'$, if C′ is positive, may arise from a vertical bar of soft iron placed on the starboard side and below the compass, or on the port side and above it.

$\frac{P'}{\phi\cos\theta}\sin\zeta' + \frac{Q'}{\phi\cos\theta}\cos\zeta'$ must arise from iron having permanent magnetism.

$D\sin 2\zeta'$, if D is positive, may arise from a horizontal bar of soft iron placed in the midship section, and either before or abaft the compass. If D is negative, it may arise from a horizontal bar of soft iron directed towards the compass, but at right angles to the principal section.

$E\cos 2\zeta'$ may arise from a horizontal bar of soft iron directed towards the compass, but inclined 45° to the bars in the last-mentioned case, the bar being before and to the starboard side, or abaft and to the port side if E is positive; and before and to the port side, or abaft and to the starboard side, if E is negative.

From the manner in which B′ and P′, C′ and Q′ are involved in this expression for δ, they cannot be separately determined from observations made in one geographical position. If they were constants, they might be determined from observations made in any two geographical positions, and we might then predict the change which would take place when the ship changes its geographical position. But unfortunately the values of P′ and Q′ change so much, that no reliance can be placed on such determinations.

If we represent the value of the deviation by the simpler formula

$$\delta = A + B\sin\zeta' + C\cos\zeta' + D\sin 2\zeta' + E\cos 2\zeta',$$

keeping in mind what B and C represent, then the following observations suggest themselves:—

A, D, and E are independent of the dip and force, and consequently of the geographical position of the vessel, and ought to remain the same in all latitudes; and this we find to be the case, subject to this observation,—that A and E being generally very small, the changes in their values, though absolutely small, may be large relatively to their value. The value of D, which in iron vessels, as might be expected, is generally considerable, is remarkably permanent in different geographical positions.

In wooden ships, P′ and Q′ are generally very small; B and C, which are generally the largest coefficients, vary as the tangent of the dip, and the deviation changes its direction when the ship changes from a northern to a southern magnetic latitude.

In iron ships, P′ and Q′ seem to be considerable.

If B′ and C′ were small, the part of the deviation depending on B and C would vary inversely as the horizontal force. It would therefore be a minimum at the magnetic equator, and would increase as the ship went to a distance from it on either side. But even in iron ships the values of B′ and C′ seem to be considerable, except for places in the ship where by accident there is a compensation of the effects of the soft iron. And if we consider the different combinations which may exist, we shall see how very uncertain any prediction as to the change in the deviations on a change of magnetic latitude must be.

Thus, if in England we have selected a place for the standard compass in which the deviations are small, this may arise from the magnetism of the soft iron counteracting that of the hard iron; but if so, in southern latitudes they will conspire, and cause a large deviation.

Again, a place may happen to have been selected for the compass in which there is a compensation of the magnetism of the soft iron, and in which therefore the deviation is caused solely by the hard iron. In this case, in a southern latitude the deviation would have the same sign and amount. If the magnetism of the soft iron be not entirely compensated, the deviation in a southern latitude will be less or greater than in a northern, according as in the northern latitude the soft iron conspired with or acted against the hard iron.

The values of the coefficients A, B, C, D, E, in every case must be determined by observations of the deviation made with the ship's head on different azimuths. Observations on any five azimuths would give the values of these coefficients, but it is more advantageous to make the observations on eight, or sixteen, or even thirty-two equidistant points, and combine the equation by the method of least squares. The mode of doing this, with forms for the calculations, is given in the Supplement to the 'Practical Rules for ascertaining the Deviation,' &c., published by the Admiralty.

We may conclude this communication by giving the values of the coefficients computed from deviations observed in several iron and wooden ships in different geographical positions.

H.M. Iron S. V. *Torch.*	A.	B.	C.	D.	E.
Greenhithe, May 10, 1852	0° 4′	10° 41′	0° 46′	2° 43′	−0° 24′
Madeira, July 6	−3 2	6 25	1 20	2 52	0 5
,, ,,	−2 48	6 52	0 57	2 10	0 43
Porto Grande, St. Vincente, July 22	1 40	7 4	1 10	2 46	0 52
Rio, Sept. 29 (Bad swinging)	−3 6	3 55	−1 12	−1 25	0 51
,, ,,	0 7	7 17	1 6	2 30	−0 10
Tristan d'Acunha, Nov. 16.	−0 12	7 42	3 13	2 23	0 56
Simon's Bay, Dec. 10	1 17	9 18	−0 30	1 57	0 6

	A.	B.	C.	D.	E.
H.M.S. *Herald.*	° ′	° ′	° ′	° ′	° ′
Greenhithe, May 13, 1852.	0 5	2 6	−0 7	0 15	
Madeira, June 29	−0 8	2 5	−0 25	−0 4	−0 4
St. Vincente, July 22	0 7	0 56	−0 40	0 21	−0 12
Rio, Sept. 27	−0 20	−0 13	0 13	0 48	−0 8
Cape of Good Hope, Nov. 30	−0 13	−1 45	0	0 9	0 15
St. Paul's Island, Jan. 24, 1853	−3 33	−1 38	0 20	0 17	−0 17
Sydney, Feb. 23	−1 22	−0 52	−0 16	0 17	1 37
Isle of Pines, Sept. 28	−1 21	−0 30	0 45	0 51	0 22
Sydney, Jan. 3, 1854	−1 2	−0 50	−0 14	0 2	1 1
H.M. Iron S.V. *Vulcan.*					
Portsmouth, July 1, 1852	−0 13	−8 47	0 43	3 37	−0 44
Simon's Bay, Feb. 1853.	1 8	−16 3	1 19	4 15	0 51
H.M. Iron S.V. *Simoom.*					
Portsmouth, Sept. 1852	−0 7	20 7	−7 18	4 33	−0 19
Simon's Bay, Oct. 1853	−1 47	13 6	−2 23	4 13	0 22
H.M. Iron S.V. *Trident.*					
Greenhithe, Sept. 8, 1852.	0 2	19 36	−2 43	3 33	0 26
Rio, Nov. 7, 1852	−0 8	12 18	−1 47	3 54	−0 15
H.M. Wooden S.V. *Virago.*					
Plymouth, Sept. 1851	0 17	7 38	0 53	1 12	−0 2
Rio, Nov. 1851	−0 15	1 20	0 40	1 56	0 10
Valparaiso, Sept. 27, 1852	−0 10	0 17	0 58	1 41	0 8
H.M.S. *Pandora.*					
Plymouth, Feb. 1851	−0 46	2 31	0 16	0 38	0 18
Auckland, New Zealand, Jan. 1853	−0 42	−2 22	0 42	0 33	
H.M.S. *Mæander.*					
Sheerness, Sept. 1852	−0 15	1 10	0 30	−0 15	0 8
Simon's Bay, March 1853	−0 23	−2 35	−0 3	−0 10	0 6

The following are approximate values of the magnetic elements at the places in question.

	Dip.	Tan. Dip.	1 / Hor. force.
	° ′		
Greenhithe	69 0	2·6	2·04
Madeira	61 0	1·8	1·62
Porto Grande, St. Vincente	48 0	1·1	1·26
Rio	−13 0	−0·23	1·20
Tristan d'Acunha	−39 30	−0·825	1·46
Simon's Bay	−53 0	−1·327	1·66
Sydney	−63 0	−1·962	1·17

Thirteenth Report of a Committee, consisting of Professor DAUBENY, Professor HENSLOW, *and* Professor LINDLEY, *appointed to continue their Experiments on the Growth and Vitality of Seeds.*

THE seeds subjected to experiment this year were the oldest of the set preserved for the above purpose in the depot at Oxford, having been gathered in the years 1834, 1835, 1836, 1837 and 1841, and, as will be seen by reference to the annexed Table, few of them retained their vitality up to the present date.—September 1854.

Name and Date when gathered.	No. sown.	No. of Seeds of each Species which vegetated at			Time of vegetating in days at			Remarks.
		Oxford.	Cambridge.	Chiswick.	Oxford.	Cambridge.	Chiswick.	
1834.								
1. Arabis lucida	500							
2. Hypericum Kalmianum	150							
3. Passiflora Herbertiana	125							
4. Pinus Pinea	20							
1835.								
5. Berberis Aquifolia	20							
6. Euphorbia Lathyris	25							
7. Gilia capitata	500							
8. Gypsophila elegans	500							
9. Hypecoum procumbens	50							
10. Polemonium gracile	125							
1836.								
11. Clematis erecta	50							
12. Coreopsis Atkinsoniana	300							
13. Eschscholtzia, sp.	200							
14. Hypecoum procumbens	50							
15. Lupinus polyphyllus	100	5	6	......	6	8		
16. Mimulus moschatus	1000							
17. Ononis angustifolia	100							
18. Pentstemon pubescens	500							
19. Potentilla, sp. (Douglas)	400							
20. Tacsonia pinnatistipula	50							
21. Turritis retrofracta	500							
1837.								
22. Allium fragrans	150							
23. Calandrinia grandiflora	200							
24. Camassia esculenta	100							
25. Chryseis crocea	100							
26. Clarkia elegans	500							
27. Conium maculatum	150							
28. Delphinium flexuosum	200							
29. Geum, sp.	500							
30. Godetia lepida	250							
31. Lupinus grandifolius	100	1	....	......	13			
32. Œnothera, sp. (Douglas)	600							
33. Oxyura chrysanthemoides	75							
34. Papaver orientale	500							
1841.								
35. Beans	25							
36. Barley	100							
37. Buckwheat	50							

Name and Date when gathered.	No. sown.	No. of Seeds of each Species which vegetated at			Time of vegetating in days at			Remarks.
		Oxford.	Cambridge.	Chiswick.	Oxford.	Cambridge.	Chiswick.	
1841 (continued).								
38. Cabbage	50							
39. Canary	100							
40. Caraway	200							
41. Carrot	100							
42. Clover	150							
43. Cress	100							
44. Flax	150							
45. Hemp	50							
46. Kidney-beans	25							
47. Lettuce	50							
48. Oats	100							
49. Parsley	50							
50. Parsnep	100							
51. Peas	50							
52. Rape	150							
53. Turnip	300							
54. Vetch	50							
55. Wheat	100							
56. Æthusa cynapioides	100							
57. Antirrhinum majus	300							
58. Calendula pluvialis	100							
59. Collinsia heterophylla	300							
60. Datura Stramonium	100							
61. Gilia achillæifolia	200							
62. Lasthenia glabrata	200							
63. Ligusticum Levisticum	100							
64. Pæonia, mixed varieties	100							
65. Verbascum Thapsus	500							

NOTICES AND ABSTRACTS

OF

MISCELLANEOUS COMMUNICATIONS TO THE SECTIONS.

NOTICES AND ABSTRACTS

OF

MISCELLANEOUS COMMUNICATIONS TO THE SECTIONS.

MATHEMATICS AND PHYSICS.

MATHEMATICS.

On the Solution of Cubic and Biquadratic Equations.
By ARTHUR CAYLEY, *F.R.S.*

On an Extension of Quaternions.
By Sir W. R. HAMILTON, *LL.D.*, *M.R.I.A.*

The author showed how, by a slight change in the formulæ of quaternions which he had already published, and a slightly different interpretation of the sector and versor, they became applicable to the investigation of the properties of the spheroid.

The Abbé Moigno presented to the Section a new Arithmometer, or Calculating Machine, by M. T. De Colmar; and as the Abbé spoke English with difficulty, he requested Prof. Wilson to explain the machine to the Section. The machine, which was very beautifully executed, consisted of an oblong box, about 30 inches long by 6 inches wide. On the face, the machine was furnished with a handle to turn round a number of small holes, at which the digits of the common arithmetic scale, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0, made their appearance as the machine worked, and which finally gave the answer. In this machine they were eight in number, but they might be extended to any number. To each of these was an index to be set to the required digit, engraved on a small attached vertical scale, and a small ivory ball to be moved along its scale according to certain simple rules, as the operation to be conducted by the machine varied from addition to multiplication, &c. Upon drawing out the sliding bottom of the machine, the machinery was exposed to view. This, though simple, could not be intelligibly explained without the machine or diagrams. The chief part of it consisted of eight cylinders so arranged, that, as they turned, the digits, enamelled on a circle at their upper parts, came in succession to the holes in the face; while by a number of indentations arranged spirally round them the digit to which the index was set would be stopped at the hole on the face at the digit corresponding to that at which the index was set; while by a set of pinions a connexion was given to them something similar to that in the common bank-note machine, so that addition could be performed and the result appear on the face :—thus by turning the handle once, the number itself appeared; by turning it twice every digit in it was doubled; and the result appeared above as twice the number originally set, and so on with any multiple of the number so set; then by moving the ivory ball any simple multiple of 10 times, 100 times, 1000 times, the number set could be obtained and added to those previously obtained, and thus the operation of multiplication performed of any number by any number to the extent the machine could give, in this case up to 99,999,999 or nearly 100,000,000. The Professor then exemplified this, by setting a large number and multiplying it by a number which consisted of three digits. He then explained how the other operations were to be performed,—showing that the machine could add, subtract, multiply, divide, raise to an integer power, or extract the square or cube root with precision and rapidity. The price of the machine exhibited was £50.

Prof. Wilson then, on the part of the Abbé Moigno, presented and explained Babinet's Homalographic Maps. In the maps on Mercator's projection, although the relative geographical positions were accurately and simply laid down, yet there was a great distortion, particularly in those lands and seas towards and about the Polar regions; and the same remark was more or less applicable to all the ordinary projections used in maps. But in those of M. Babinet, by making the principal meridians in both hemispheres straight lines, and the others, on each side of them, arches of ellipses passing through the Polar points, and their ellipticity varying with their position by a simple law, the exact harmony and proportion of the several parts, land and water, countries and places, on the map were correctly preserved when accurately laid down. M. Moigno presented to the British Association through this Section a map of the world on this construction.

LIGHT, HEAT, ELECTRICITY, MAGNETISM.

On a New Photometer. By M. BABINET, *of Paris.*

This photometer consisted of a tube, at one end of which was a Nicol's Prism, through which the light to be valued is admitted, the radiant or source of the light being placed at a measured distance. As it passes along the tube the light encounters a bundle of glass plates through which, as it passes, it is polarized by refraction. It then passes on and is received at the eye-pieces; another tube, furnished also at its extremity with a Nicol's prism, also enters the side of this first tube at such a place and at such an angle as that light admitted from a standard source at a fixed distance is reflected to the eye-piece by the same bundle of parallel glass plates, through which the former light is refracted. By turning the Nicol's prisms, exact complementary colours can be had from each source, and where the images of oblong slits, through which the light passes, are made to cross at the eye-piece, the crossed part will be free from either colour when the light to be tried is at exactly the distance which gives the same intensity to the light which enters the instrument as that which comes from the standard. A comparison of the squares of these distances gives the intensity of the light to be valued, in the usual and well-known method.

Note on Indices of the Refraction of Transparent Media included between two Parallel Faces, and on a Portable Refractometer, exhibited to the British Association for the Advancement of Science. By Dr. FÉLIX BERNARD, *of Bordeaux.*

The indices of refraction of parallel plates and liquids may be measured by a very simple method founded on the following principles[*]:—

1. Every ray that falls perpendicularly upon the surface of a transparent medium with parallel faces traverses it without deviation.

---

[*] The author had already made a communication to the Academy of Sciences relative to the determination of the indices of thick plates, but the apparatus referred to in this Note had not been exhibited before that body.

2. When the incidence is oblique, the ray refracted in this medium emerges from it in a direction parallel to that of the incident ray, and the distance included between these two directions, or the *transport*, only depends on the angle of incidence, on the index of refraction of the refractive medium, and on the thickness of this medium.

From the relation subsisting between these four quantities we may therefore deduce the index of refraction, if the three others be known; the incidence may be chosen at pleasure, the thickness is easily measured, and the transport, the only unknown quantity, is determined by observation.

Let a be the angle of incidence, ρ the angle of refraction, e the thickness of the medium, and n the index of refraction for a ray which traverses the plate ½ d the distance sought, then

$$n=\frac{\sin\alpha}{\sin\rho},\ \text{tang}\ \alpha=e\ \text{tang}\ \rho+\frac{d}{2\cos\alpha},$$

hence

$$n=\sin\alpha\sqrt{1+\left(\frac{2e\cos\alpha}{2e\sin\alpha-d}\right)^2}.$$

This formula will give n, when e being measured and a given, d has been determined experimentally.

The apparatus which serves for the determination of d is composed—

1. Of a sight formed by a spider's thread fixed vertically in the interior of a horizontal tube; at one extremity of this tube is a diaphragm, through the aperture of which the light penetrates into the apparatus; a lens placed between the sight and the diaphragm, and capable of motion in the direction of the axis of the tube, allows the light received to be conveniently regulated.

2. Of a horizontal circle for the determination of the incidences; at the centre of this circle there is a support which may be turned by an alidade traversing the limb of the circle.

3. Of a telescope furnished with two very fine wires crossing in the focus of the eye-glass; its optic axis is parallel to that of the tube containing the sight, and it is capable of motion in a direction perpendicular to this axis. The amount of motion is measured and effected by means of a micrometric screw.

Mode of operation.—The index of the alidade is placed so as to coincide with the zero of the circle; the telescope is pointed towards the sight, and the lathe is placed in focus; the plate is then fixed vertically against a frame placed on the horizontal tablet of the support, and by turning it on its axis, without disarranging the alidade, the position which it should retain, which is such that the sight may be perceived without deviation, may be found in a few seconds.

To determine d, the alidade is turned to an angle a, and then to an angle $-a$, moving the telescope so as to point it upon the sight in both positions of the refracted image; the space passed through by the optic axis of the telescope, ascertained by means of the screw, gives the value of d. The very trifling errors which might arise from a slight obliquity of the plate in relation to the direction of the incident rays may be compensated in the following manner:—If the plate be slightly prismatic, it is turned upon its axis 180°, and the distance of the emerging parallel rays is again measured; the average of the values thus obtained will give a very close approximation to the distance sought. I have ascertained positively that a want of parallelism in the plates, even when very sensible by the spherometer, does not affect the exactitude of the observations.

The sight may receive either the rays of the solar spectrum, or the light of a strong lamp modified by suitable absorbents, or it may be illuminated by a bundle of white light; in this the average index of refraction of the refractive body is obtained, and this is very often sufficient.

The thicknesses may be measured by means of any spherometer, but in this case it is necessary to determine the relation between the lengths of the turns of the screws in the two instruments, which is not attended with any difficulty; it is sufficient to determine the value of d, for a substance of which the relative index to a ray of the spectrum is known; the value of e may then be deduced from the preceding formula. This quantity will usually differ from that furnished by the spherometer, but their relation will always enable the values of e and d to be compared with the same nicety. Nevertheless, in order to avoid this correction, M. J. Duboscq has given a very simple disposition to the micrometric part of the apparatus, so that when the telescope which moves the screw is removed, it readily forms a very delicate spherometer.

By operating in this manner, but with a very imperfect apparatus, I found, for the indices of refraction of the ordinary ray by plates of quartz of 7 to 8 millimetres in thickness, the numbers 1·5441, 1·5473, 1·5496 and 1·5541, which correspond respectively to the rays D, E, F, G. These numbers do not differ from those given by M. Rudberg by more than $\frac{2}{10,000}$ths at most.

This process may be advantageously employed in researches relative to the indices of refraction of liquids; the mode of operation is so simple that I may dispense with entering into details upon this subject.

Description of a Photometer exhibited to the British Association for the Advancement of Science. By Dr. Félix Bernard, *Bordeaux.*

The photometer which I have the honour to bring before the Association has been exhibited by M. Arago to the Academy of Sciences, at its meeting of the 9th of May 1853. This instrument, which is principally intended for the study of the transparency of bodies, may be very advantageously employed in a great number of photometric investigations, regarding the illuminating power of luminous bodies, the diffusion of light, and its reflexion from the surfaces of bodies, &c. I shall describe particularly the arrangement which I have adopted for ascertaining the absorption exercised upon light by the action of transparent media.

In this case the anterior portion of the instrument presents a tube furnished with two diaphragms, through which the luminous rays, previously rendered parallel by means of a lens, penetrate into the apparatus. At their entrance into the body of the instrument, the rays fall perpendicularly upon the middle of the surface of a double prism, formed by the union of two equal, rectangular, isosceles prisms, of which two faces are in the same plane. The bundle formed by these rays, on meeting the edge of the right dihedral angle of the hypothenuses, is divided into two other equal bundles, which are entirely reflected in opposite directions perpendicularly to that of the incident bundle. At a few centimetres from the axis there are two reflecting prisms, by means of which the rays are reflected in a direction parallel to the axis. Farther on the new bundles traverse some Nicol's prisms which serve to polarize and analyse the light, and by a second arrangement of reflecting prisms symmetrical with the first, these bundles, after passing through the Nicol's prisms, are again turned towards one another and reflected upon the hypothenuses of a second double prism, so as, by their reunion, to reconstitute the primitive bundle. This bundle then traverses a tube forming the ocular portion of the instrument, and arrives at the eye as though it had never undergone any deviation.

At one extremity of the ocular tube and close to the surface of emergence of the double reflecting prism, there is a diaphragm, the aperture of which cuts off a circular image upon this surface; this is magnified by a lens.

The rotation of the analysers is measured upon two vertical semicircles by means of alidades furnished with verniers.

The apparatus being arranged, that is to say, the extinction being complete when the verniers are at zero, the intensity of each half of the circular image perceived by the eye varies in proportion to the square of the sinus of the angle described by the principal section of the analyser; and consequently if one of them be rendered more obscure by the interposition of an absorbent medium in the course of the bundle which corresponds with it, it becomes easy to estimate its intensity, when, by a suitable rotation of the analyser corresponding with the other half, the two parts of the image have been rendered uniform in tint.

The artificial light emanating from a strong lamp may be operated with, but before arriving at the apparatus, this light should traverse a system of absorbents arranged in such a manner that the light transmitted may belong to one of the principal tints, almost monochromatic with the solar spectrum. It is better, however, to employ the direct light of the spectrum, by receiving on a screen furnished with a slit, a very fine vertical spectrum formed in the usual manner by rays rendered parallel by means of lens (the principal lines of Fraunhofer should then be seen distinctly); the rays which have traversed the slit are received in the apparatus. It is advisable, in this case, to replace the diaphragm at the entrance by a system of two lenses forming a collineator; the polarization of the parallel rays is then complete.

The light which reaches the eye is sometimes very bright; it then becomes necessary to deaden it by placing a piece of ground glass before the collineator.

In studying reflexion or diffusion, or comparing the intensities of two luminous sources, the entire system of prisms placed in the anterior part of the apparatus is renewed; the arrangement of the two separate bundles, which are afterwards united by means of the other system of prisms, may be easily understood.

When the absorption of light is to be determined, the apparatus may receive some modifications by which it is simplified. The luminous bundle, before its divisions, falls upon a Nicol's prism which polarizes it, and afterwards upon a bi-refractive prism which divides it; by means of an arrangement of reflecting prisms similar to the preceding, a circular image, composed of two parts polarized in two rectangular planes, is obtained.

The Nicol's polarizing prism also serves as an analyser with regard to the light which has traversed the bi-refractive prism; the rotation of this prism is also measured by means of an alidade through which it is put in motion. One of the images increases in intensity in the proportion of the square of the sinus of the angle formed by the principal sections of the analyser and of the bi-refractive prism; the other decreases in the proportion of the square of the cosinus, and their relation varies in proportion to the square of the tangent of the same angle.

An indispensable precaution to be taken in these experiments is to place in front of the analyser a thick plate of rock crystal parallel to the axis, in such a manner that its principal section may be parallel to that of the analyser. Nicol's prisms cut in the ordinary manner, and inclined in the tubes enclosing them so that they may not produce a sensible deviation of the luminous rays, form excellent analysers when furnished with a similar plate, rendering unnecessary any correction with regard to the variation in the quantity of polarized light reflected at the first surface of these prisms, when they are turned upon their axes. Nicol's prisms cut in the form of right parallelipipeds do not answer the same purpose here, as they cause too great a transport of the incident ray.

The apparatus which forms the subject of this Note, which was constructed by a clever artist, M. Duboscq, may be readily adapted to all the preceding modifications: by simply taking it to pieces, suppressing some of its component parts, and adding the bi-refractive prism, the last-mentioned arrangement is produced.

By means of this apparatus it is easy to prove that the absorbent action of coloured media only influences the *intensity* of the light, the peculiar arrangement of the apparatus protecting the eye from the errors which are almost inevitably produced by contrasts of intensity of colour, when the spectrum is examined through similar media. There is consequently nothing to invalidate Newton's opinion as to the simplicity of the prismatic colours which is generally adopted by physicists.

I regret exceedingly that I am still unable to bring forward the whole of the researches in which I am engaged, principally in a chemical point of view, as to the relative transparency of bodies to the principal rays of the spectrum; but I hope hereafter to have the honour of bringing forward the results of these experiments at some of the meetings of the Association.

Note on Polarimetry. By Dr. Félix Bernard, *Bordeaux.*

When some point of clear sky is examined with a polariscope, it is found that the light reflected by the different strata of the atmosphere is generally polarized. In certain regions the polarization is very distinct, whilst other parts only exhibit a very slight polarization, or even none at all; and this condition, which varies more or less rapidly in accordance with very various causes, is subject to laws, with the most general of which we are acquainted, but from which we have as yet learnt scarcely anything as to their relations with the meteorological phænomena to which they are allied. The researches of MM. Arago, Babinet, and Brewster have proved the existence in the celestial arch of some remarkable points in which two antagonizing polarizations neutralize each other; these physicists have made known the position of these points and the law of their displacement; the points corresponding with the maximum of polarization have been studied, and the lines of equal polarization have been determined in a particular case, but it cannot be denied that much still remains to be done.

When allowance is made for the accidental circumstances which often introduce such great perturbations into the celestial polarization, there should exist, for each place of observation, a normal state of polarization, depending exclusively upon the position of the sun and local circumstances, which ought to be characterizable by means of polarimetric observations. The following method, founded on the comparison of the intensities of two images which are brought to equality under the most favourable circumstances (*i. e.* when they are of the same colour and in contact), may be employed in this case with advantage.

Let a and b be the intensities of two polarized bundles of rays, which together are equivalent to the partially polarized bundle, the vibrations of the two component bundles being respectively parallel and perpendicular to that of the polarized portion of this bundle, the quantity of polarized light therein contained will have the value $\frac{a-b}{a+b}$, or simply $a-b$, taking $a+b=1$, which is the quantity to be estimated.

Polarimeter.—The luminous bundle, after traversing some narrow diaphragms arranged in a tube of a length equal to 2½ diameters, falls upon a doubly refractive prism, which produces, by refraction, two images of the opening of the most distant diaphragm. A Nicol's analysing prism, cut into the form of a right parallelipiped, is placed in the centre of a fixed circle, the axis of which coincides with that of the tube; an alidade furnished with a vernier allows the rotation of this to be measured. Immediately against the terminal diaphragm, there is a cap with an opening of 5 millimetres in diameter; it is this that furnishes the two polarized images; the other bears a Soleil's quartz-plate, with two rotations, which serves as a polariscope. The position of these two openings may be changed at pleasure in the direction of the axis of the apparatus. The whole system is enclosed in a concentric, cleft tube, furnished with a hinge; by this arrangement it may be turned upon its axis and fixed in any position by means of a screw. The apparatus thus arranged is the *polarimeter.*

Atmopolarimeter.—To adapt this instrument for observations on atmospheric polarization, it is placed upon a vertical columnar support, standing on a tripod with screw feet. At the upper part of the support there is a horizontal circle, provided with levels and a compass, to furnish the azimuth of the point observed; a vertical semicircle placed towards the upper part of the column serves to determine the elevation of this point, and a parallactic circle enables the instrument to be easily arranged according to the great circles of the sphere.

To ascertain exactly the angular distance from the sun to the point under observation, a small finder is arranged parallel to the telescope bearing two crossed wires at one of its extremities, and at the other a small disc of transparent paper, upon the centre of which the shadow of the point of intersection of the two crossed wires will be thrown when the apparatus is directed to the sun*.

Before making an observation, the horizontality of the azimuthal circle is determined by means of the levels and supporting screws of the tripod; the vernier of the vertical circle being at zero, the parallactic circle and the polarimeter must necessarily be horizontal. When the orientation of the apparatus has been effected, and it is directed towards the point of the sky under examination, the double quartz-plate is lowered upon the axis of the polarimeter, and the latter is turned upon its axis until the uniformity of coloration of the two discs corresponding with each image indicates the parallelism or perpendicularity of the principal section of the polarizer to the plane of polarization. The aperture of the cap is then substituted for that of the polariscope when the difference in the intensity of the two images becomes manifest, but this difference disappears when the principal section of the analyser forms a certain angle, α, with that of the polarizer; from this it follows that if the principal section of the polarizer be parallel to the plane of polarization, the relation between the intensities of the two bundles transmitted is

---

* The portion of the apparatus devoted to the orientation and pointing of the polarimeter presents the same arrangements as a great number of instruments, and does not differ from that adopted by Peltier in his modification of Arago's polarimeter.

$$a \sin^2 \alpha = b \cos^2 \alpha, \text{ whence}$$

$$\frac{b}{a} = \mathrm{tg}^2 \alpha;$$

but we have already $a+b=1$, consequently

$$b=\sin^2 \alpha,\ a=\cos^2 \alpha,\ a-b \cos 2\alpha.$$

It is not absolutely necessary that the zero of the circle should correspond exactly with the azimuth of extinction of one of the two images; two observations may be made, one on each side of this point, noting the angles, ϕ, ϕ', which correspond with the equality of the images; we then get $\alpha = \frac{\phi+\phi'}{2}$.

The method just described is evidently applicable to the study of the polarization of light reflected from the surface of solids and liquids; the arrangement of the apparatus for this purpose is too simple to render any details necessary.

The very recent construction of the apparatus* has not allowed me as yet to make any continuous observations with it, but I have already been able to assure myself of the precision with which it acts, by making hourly observations at Paris for two consecutive days upon the polarization of a point belonging to the very limited portion of sky which was within my view; the comparative results did not differ by one hundredth.

On the Origin of the Submarine Telegraph and its Extension to India and America. By JOHN W. BRETT, *London.*

After claiming for himself and his brother, Mr. Jacob Brett, the honour of being not only the first inventors, but also the first projectors, of a Submarine or Oceanic Telegraph, the author proceeded to give an account of the difficulties and prejudices they encountered in establishing the first submarine telegraph, which has now been successfully working for three years between France and England; and stated that he had established the submarine telegraph between England and Belgium with equal success, which had been in operation since the 1st of May 1853. He then explained some of the difficulties he had encountered in laying down the two submarine lines in the Mediterranean in July last,—especially in passing a depth exceeding, by 100 fathoms, what had previously been ascertained to exist on the route between Piedmont and Corsica. The depths encountered between England and France, and England and Belgium, did not exceed at their maximum 30 fathoms; whereas the submarine cable was laid down in the Mediterranean at a depth of 350 fathoms, exceeding about eight times that of the English Channel. It was the general impression that the submarine cable would part by the great strain it would encounter in passing these great depths; for which reasons he was strongly advised, and more particularly by one of the most able and experienced officers of the Sardinian Government, who accompanied and aided the undertaking, to make a détour of about eight miles by the islands of Gorgona and Caprija, where the soundings were known not to exceed 100 fathoms; but the great point to be considered was, whether he would not incur the risk of a total loss of the cable by not doing so. The prudence of these arguments Mr. Brett said he fully admitted; but that it was a question he was determined to solve at once; for as this telegraph was not a telegraph to Corsica, but part of a line to India, to be shortly completed to Africa, where still greater depths must be encountered, it was necessary to test the fact. He then explained the difficulties they encountered in paying it out, when, after the line had been paid out, as he believes, along the top of a submarine mountain for some miles at a depth varying from 180 to 200 fathoms, it suddenly, as he believes, came to the edge of a precipice, making a total of 350 fathoms (exceeding by about 100 fathoms any depth marked in the various charts on this route), where it ran out with frightful velocity;

---

* This instrument was made in the workshops of M. Duboscq, and has hitherto only been exhibited to the British Association for the Advancement of Science.

and had the cable been less strong, the whole must, of necessity, have been lost; and they were compelled, nevertheless, to anchor by the electric cable all night, to restore the injury that had occurred; but he felicitated himself upon the experience thus gained from his determination in taking the deepest route, as it had led to many valuable suggestions necessary to successful operations in great depths; and the able commander, the Marquis Ricci, who up to this time had been in doubt of its success, then admitted that this kind of cable contained such remarkable elements of strength in its form and combination, that he believed only certain improvements to be necessary (on which we had been consulting) to lay it down successfully even in the greater depths of the Atlantic. Mr. Brett, in conclusion, explained his reasons for selecting this line to India, *viâ* Egypt, in preference to the line by the Italian peninsula, which would ever be impeded by the jealousies and restrictions of the petty States; whereas, to the shores of Africa, the Mediterranean Telegraph passed through only the States of France and Sardinia, who had encouraged it by liberal guarantees, and admitted that all communications in whatever language should pass unrestricted through their States. From Africa he stated he had two plans in contemplation for its extension to Egypt—one, a line dropped in the Mediterranean in the shallow line near the coast, and another buried in the sand along the shore,—both of which he was satisfied might be laid secure from derangement of any kind. He then concluded with a statement of the labour and attention he had given for many years in preparing for the telegraph to America, and of the depth, on the proposed line, as recently ascertained by Lieut. Maury, of the United States, with some estimates of the weight and cost; and stated that a return of £100 to £150 per day would give a fair interest on the necessary capital; that his plan comprised several lines of communication; and that he entirely deprecated the idea of a single line of communication, which he believed could not be done.

On Magneto-Electricity and Underground Wires.

By EDWARD B. BRIGHT, *Liverpool.*

Magneto-electricity, as well known, is the current induced in a coil of insulated wire when moved before the poles of a permanent magnet, a positive current being manifested at one end of the coil, and a negative current at the other, upon any movement of the coil before the poles. The greatest demonstration of the induced currents occurs when the coil used is electro-magnetic (*i. e.* wound upon a soft iron core).

As applied to telegraphic purposes, the iron core of the coil, when at rest, partly serves as a keeper to the magnet, though not actually in contact with its poles; and when worked by a key attached to the axle, the coil moves freely to and fro before the magnet, generating a current with each change of position, which is applied to actuate indicators or ring bells at a distance. This principle constitutes the system of the Magnetic Telegraph Company; all other Companies in this kingdom and America have adopted the galvanic battery.

The generating magnets have remained unimpaired in strength during three years of constant use (a period in which a dozen consecutive sets of voltaic batteries would have been worn out). The magnetic currents induced can be passed through subterranean wires to a distance of 660 miles (the greatest extent of such conductors in England) without any break or renewal of circuit.

The return (or *recoil*) currents from underground wires, which has interfered with the working of other telegraphs, is applied in the magnetic apparatus, and assists in working it, being made to keep the indicating needles at zero until actuated from a distant station.

A remarkable feature in underground wires is the small comparative velocity with which the electric sensation passes through such conductors: Professor Wheatstone's experiments on a short length of wire in a room have demonstrated that *frictional* electricity passes at nearly 300,000 miles per second; such currents cannot, however, be practically applied or insulated for telegraphic purposes. Professor Walker's (America) give the speed of galvanic electricity through *overground* telegraph wires at only 16,000 miles per second; while lastly, experiments conducted by the engineer of the Magnetic Company on an underground length of 480 miles of gutta percha covered copper wire, show that the voltaic or magnetic impulse varies in velocity, through such conductors, from 960 to 1700 miles per second, according to the intensity of the current employed.

The diminution in *velocity*, as regards the underground wires, is intimately connected with the recoil current recently analysed by Dr. Faraday, and is due to the analogy between such conductors and a Leyden jar, the charge communicated being temporarily absorbed by the wire until the mass of copper is saturated with electricity. Hence a retardation ensues to a less or greater degree as the intensity of the current is increased or diminished.

From the foregoing I deduce that the *speed* with which electricity passes, varies with the energy (*i. e.* intensity) of the current employed, and also with the nature or conditions of the conductor interposed through which it passes.

Underground wires are only affected by terrestrial electricity when a flow takes place from one district of the earth's surface to another; while overground wires are also subjected to the action of perturbative currents whenever the electrical '*status*' of the atmosphere changes as regards the earth—principally with the rise or fall of dew, or during aurora borealis.

The 'Quarterly Review' for June 1854 contains a most erroneous comparison between the English and American telegraph charges. The American rate for a message of fourteen words between Louisville and Pittsburgh is stated by the 'Review' to be sixpence halfpenny, whereas, upon reference to the United States 'Telegraph Tariff,' published in April last, the cost of such a message is two shillings and eightpence, while the English charge for a similar communication an equal distance (between London and Liverpool), prior to the publication of the 'Review,' was two shillings and sixpence. Twenty words might be sent in this country for the same amount (two and sixpence), while in America the charge would be three shillings and sixpence.

The 'Quarterly Review' also states that the cost of a message of ten words from New York to New Orleans is two shillings and sevenpence. Upon referring to the American tariff scale it is found to be *ten* shillings.

The greater œconomy claimed by the 'Review' for America does not exist, but the advantage is on the English side; and I therefore hope that this refutation will prevent an impression so injurious to the system of our country from being generally received.

On an Apparatus for elliptically-polarized Light. *By* M. Dove, *Berlin.*

If a ray of light be incident in a plane perpendicular to the edge of an isosceles prism, and in a direction parallel to the base (or face equally inclined to the two others), and the refracted ray, after being totally reflected at the base, emerge at the third face, the emergent ray will be parallel to the incident, and its course may even be a continuation of that of the incident ray. If the incident ray be polarized, the polarization will be modified by total reflexion. If now two such prisms, of proper angles, be mounted in a tube, so that their edges are perpendicular, and their bases parallel to the axis of the tube, and one of the prisms be moveable about the axis of the tube, a ray entering the tube in the direction of the axis will pass through both prisms without deviation, whatever be their relative azimuths. If the prisms be placed with their bases perpendicular to each other, it is plain that in case the ray be polarized, its state of polarization will not be changed; but if one prism be turned round through 90°, the effects of the two total reflexions will conspire. In this way all varieties of elliptically-polarized light, from plane to circular, may be produced without the lateral transport of the ray, which is so inconvenient in Fresnel's rhomb.

On some Stereoscopic Phænomena. *By* M. Dove, *Berlin.*

The author was chiefly induced to draw the attention of the Section to this subject in consequence of Sir David Brewster, who he greatly regretted was not at this meeting, having denied at the Belfast Meeting the soundness of the explanation which the author had given of the cause of the appearance of those bodies which exhibited the metallic lustre. This he considered to arise from the superficial layers of particles being highly, though still imperfectly transparent, and permitting the inferior layers to be seen through them. This effect we see produced when many watch-glasses are laid in a heap, or when a plate of transparent mica or talc being heated red-hot is thus separated into multitudes of thin layers, each of which, of inconceivable thinness, is found to be highly transparent, while the entire plate assumes the lustre of a plate of silver. This explanation receives a very striking confirmation from the stereoscopic phænomena which he now drew attention to. He then presented to the Section and described a very simple and portable modification of the stereoscope, consisting of two lenticular prisms mounted in a frame like a double eye-glass. Upon examining with this two diagrams, drawn one for the right, the other for the left eye, with lines suited to give the idea when viewed together of a pyramid, cube, cone, or other mathematical solid, but the lines on one drawn on a white ground, the other on a dark or coloured ground, on viewing them together the solid appeared with the metallic lustre. The author termed it "Glance." This, he conceived, demonstrated his original idea to be correct.

On a Method of measuring the Absorption of Polarized Light in doubly refracting Crystals. By M. Dove, *Berlin.*

A feeble degree of double absorption in a crystal may be detected with great delicacy by using the crystal as an analyser in viewing, suppose, a piece of unannealed glass in polarized light. The same method may be modified, so as to afford a measure of the power of double absorption possessed by any crystal. For this purpose, it is sufficient to combine with the crystal a plate of glass, or a pile of plates, which is inclined until it exactly compensates the polarizing power of the crystal, which is known by the complete disappearance of the figures in the unannealed glass. The angle of inclination affords data for the determination of the ratio sought.

M. Duboscq then presented to the Section philosophic apparatus for showing in projection on a screen to a large auditory all the phænomena of light; the author was requested to permit Prof. Stokes to exhibit and explain at the evening meeting the apparatus, and to show with it the leading phænomena of light.

On Photographs of the Moon and of the Sun.

By the Rev. J. B. Reade, *M.A., F.R.S.*

The author recounts in the first place the prominent results of several trials to obtain photographic pictures of celestial bodies, previous to Mr. Whipple's success in 1851, and then proceeds to phænomena which have fallen under his own observation.

"The two daguerreotypes of the moon, an original and a copy, which illustrate this paper, will be examined with some interest by the Section. The fainter picture, produced by the moon herself, in the focus of Bond's refractor, was taken in America. It possesses a very remarkable, but latent sharpness, which, however, is so scarcely visible to the eye, that to ascribe to it this character may almost provoke a smile. The proof of its having such a property is furnished by the beautiful copy of it of the same size, which my friend, the Royal Astronomer for Edinburgh, obtained by throwing strong sunlight upon the moon's daguerreotype picture of herself, and obtaining a reverse solar impression of it in a common camera, the conjugate foci being equal. The tones of grey and yellow which mark the action of the moon, become, when handled by the sun, fine contrasts of black and white. The mountain chain round the portion of the Mare Imbrium, is finely given in the copy, though it almost requires a stretch of the mind's eye to discover some of the details in the original. The well-known ray of light from Menelaus passing through the centre of the Mare Serenitatis, is another point of striking contrast in the two pictures, as well as the outline of the shadows in several of the craters. It is said that Lord Rosse was much interested with this happy experiment by Prof. Piazzi Smyth, as it tended to solve a question which had often occurred to him respecting the probable beneficial use of penetrating sunlight under such circumstances; and in this point of view, it is well worthy of being recorded. Two Calotype examples of selenography form additional illustrations of this paper. The small moon, fastened on a corner of the larger picture, was taken by Mr. Henry Pollock with a double combination of short focus, and in less than a second. The bright point of Tycho, though on so small a scale, is well marked at the top of this minute Calotype, and the seas, to which I have already referred, give their more sombre reflection at the bottom. This is chiefly of interest as showing the decided energy of a power which in former years was supposed to be absent.

"The more important drawing is a large positive picture of the full moon, nearly nine inches in diameter, and therefore on a scale of about 250 miles to the inch, of which the negative was taken, on the 6th of September, in the focus of the 'Craig telescope,' at Wandsworth, whose diameter is 24 inches and focal length 77 feet,—and when I state that it is the first attempt, it will be received, notwithstanding certain imperfections of manipulation, which are not concealed by artificial tinting, as a step in the right direction. All the more important features of the moon's surface will be discovered by those who are familiar with their telescopic appearance, and the portion of the eastern hemisphere admits of interesting comparison with the sun's daguerreotype copy already described. We find in both, and with almost equal distinctness, the Mare Crisium with the bright surrounding country which separates it from the Mare Fœcunditatis and Mare Tranquillitatis to the south and west,—the Crater Menelaus with the ray already spoken of,—the semicircular ridge round the Mare Imbrium, and the unreflective crater, Plato, at its north-west extremity. On the western side, we have the bright Aristarchus, Kepler, Copernicus, and Tycho, with the streams of molten lava extending over the southern hemisphere; but owing to the phase of full moon, the craters and mountains are not relieved by shadows. The time of exposure of the collodion negative was thirty-five seconds; but it is evident that Tycho and the brighter portions are overworked. In the absence also of an equatorial mounting, perfect steadiness could not in the first instance be secured. Mr. Gravatt applied a micrometer screw to the eye end of the telescope, and turned it with a winch handle, and when the moon was on the meridian this was almost tantamount to an equatorial motion for the space of thirty-five seconds. A fine wire stretched across an aperture in a slip of wood was placed close behind a negative when in the focus of the telescope, and Mr. Gravatt found that by humming a tune he could turn the handle of the micrometer so steadily as to keep Aristarchus continually bisected. Mr. Prout, who prepared the collodion surface, unfortunately counted the seconds too loudly for 'the man at the wheel,' and hence arose a little cause of unsteadiness, which was afterwards prevented by my attending to the time of exposure instead of Mr. Prout. Collodion pictures of the moon, as well defined as her image on the ground glass, and taken through all her phases, would leave scarcely anything to be desired in consequence of the magnifying power of the object-glass itself; and future experiments will be directed by Mr. Craig into this channel.

"On the night of the 11th of September, we renewed our attempt when the moon was in a more picturesque position; but an undetected source of error, and the increasing density of the fog when the moon was on the meridian, prevented us from procuring a successful negative. Moreover, the true photogenic focus has not yet been obtained by means of sulphate of quinine. I may state, however, that the division in Saturn's ring, the slate-coloured ring, and the inner satellites, were well brought out with my solid eye-piece, under a power of 300; and α and ϵ Lyræ, with their minute companions, were also well exhibited. In fact, the present superiority of the telescope, though confessedly admitting of improvement in figure, consists in its command over the faintest points of light. That so large an object-glass, worked at a mechanical disadvantage by hand, and not machine polished, should do so much in its first offer to the stars, is far from discreditable to those who calculated and ground the curves; and the errors, which are now known and estimated, will be corrected by reworking the surfaces on the plan adopted by Lord Rosse and Mr. Lassell. On the 12th, the morning following, I endeavoured, with Mr. Gravatt, to take the sun on the meridian, and on the same scale as the moon; and I succeeded by an instantaneous operation in exhibiting, in the negative, the peculiar mottled character of the surface which is usually brought out by high magnifying power. Dr. Diamond, who printed the positive of the moon, found the sun picture, however, rather overdone for transferring.—It will be necessary, therefore, either to use collodion and nitrate of silver simply, without any or but little sensitive solution, or else to pass the sun's rays through some coloured glass, which will partially retard their energy. A series of pictures of the spots on the sun, as well as of the general surface, may then be successfully obtained; and hence it is not too much to anticipate some accession to our knowledge of the physical character of both our great luminaries by means of this gigantic telescope, which Dr. Diamond enables me to exhibit photographically to the Section.

On Errors which may be occasioned by disregarding the Influence of Solar or Artificial Light on Magnets. By Sir JOHN ROSS.

On the Deviation of the Magnetic Needle peculiar to Liverpool. By Sir JOHN ROSS.

The author stated that his attention has for some time been called to the fact of ships sailing from the port of Liverpool, after having been swung in the Mersey to obtain the amount of deviations, that immediately on their proceeding on their voyage it was found that the deviation observed in the Mersey was incorrect, and there have been lamentable instances of shipwreck attributed to this cause. It has occurred to him that this untoward circumstance is very easily explained. The Mersey is not a locality eligible for ascertaining the true deviation of the magnetic needle, the ships being in a position between establishments in which large masses of iron are deposited, which must have an influence on the magnetic needle during the evolution of swinging the ship, while the embarkation of passengers with their luggage, or anything else subsequent to that process, cannot but have the effect of producing a false and dangerous result to the observations. To remedy this, it is proposed that the present method of swinging the ship in the Mersey shall be continued; and, in order to obtain a verification or a correction of results observed at that time, it is proposed to place on the sandhills of Rockland (near the Rock Lighthouse), two posts or beacons, true north and south of each other, in the positions best seen near the red buoy of the Rock Channel, when the ships passing will be steering about true west, or west-north-west, by compass. When these two objects can be brought into one, *i. e.* due north of each (both being south of the ship), either a verification of the deviation that was observed in the Mersey, or the amount of difference to be taken into consideration or account on that particular point of the compass, will be shown, from which a calculation may be made in approximation of the other points; and if, further on, two other posts were erected on the magnetic meridian, the ships, on passing them, when in one with each other, could observe the exact amount of the deviation either in the increase or the diminution of the variation on the course of the ship, keeping in mind that it will be on the south point of the compass that the observations will be made. Posts placed due south of Lizard Lighthouse would be useful, and also on the magnetic meridian. But all posts or beacons denoting the true north or south bearings, and those further off denoting the magnetic meridian, should be painted of different colours. The former, that is, the true or nearest, should be red; while the latter, showing the magnetic meridian, should be chequered. Great Ormshead and Holyhead should have beacons placed on them, which would be observable to ships both outward and homeward bound.

On Pictorial and Photochromatic Impressions on the Retina of the Human Eye. By the Rev. WILLIAM SCORESBY, *D.D., F.R.S. &c.*

The author explained, with much minuteness of detail, the varying phænomena which presented themselves to him after gazing fixedly for a few seconds (or from a momentary glance to a minute) on transparent, luminous or strongly illuminated objects—such as a window, viewed from within a room, a statuette, an aperture in the clouds, the sun, &c. On closing the eyes, gently, with the head kept steady as when gazing, the image or picture was seen, or, as the author expressed it, "photographed on the retina." He described the variety of results from different degrees of transmitted light, and times of gazing, and modes of regulating the light penetrating the eyeball, both as related to the colours elicited and the number and nature of the photochromatic changes. Pictures of a window were retained for an hour, whilst breakfast was taken and other objects pursued. By means of partial black screens, pictures were *composed* out of different portions of an illuminated object, and curious dislocated representations of a statuette, &c., or multiple figures were obtained; and of the sun more than a hundred pictures, with differences of colour, were seen at once with the closed eyes. The applications of the experiments to the examination of the interior of the eye, in cases of amaurosis, &c., were very important. The entire series of phænomena would be more than our space would permit us to describe in detail, as given by the author; but experience shows that they vary in their general character in different individuals; and even the same individual finds them different, especially as to the succeeding series of photochromatic changes, at different periods of life.

On a Graphic Method of Correcting the Deviations of a Ship's Compass.
By ARCHIBALD SMITH, *M.A., F.R.S.E.*

Account of Experimental Researches in Thermo-Electricity.
By Professor W. THOMSON, *M.A. F.R.S.*

The experiments described in this paper have been made for the purpose of continuing the investigation of various branches of the subject commenced in researches, of which an account was published in the 'Proceedings of the Royal Society' for May last. In one class of experiments, thermo-electric inversions, of the kind first discovered by Prof. Cumming, were sought for between various pairs of metals; and many remarkable variations of order in the thermo-electric series were found. The following table exhibits the results of observations to determine the neutral points in various cases in which thermo-electric inversions had been ascertained. The first column is the temperature, Centigrade, at which the two metals opposite are thermo-electrically neutral to one another, and the latter metal is that which *passes the other from bismuth towards antimony* as the temperature rises:—

°		
—14	Cent.	P_3—Brass.
—12·2	„	P_1—Cadmium.
—1·5	„	P_1—Silver.
8·2	„	P_1—Zinc.
36	„	P_2—Lead.
38	„	P_2—Brass.
44	„	P_2—Tin.
44	„	Lead—Brass.
64	Cent.	P_1—Copper.
99	„	P_1—Brass.
121	„	P_1—Lead.
130	„	P_1—Tin.
162·5	„	Iron—Cadmium.
237	„	Iron—Silver.
280	„	Iron—Copper.

⁂ P_1, P_2, P_3 denote three different specimens of platinum wire, which have been found to differ very markedly and constantly in their thermo-electric qualities.

It was also found that brass becomes neutral to copper, and copper becomes neutral to silver, at some high temperature, estimated at from 800° to 1400° Cent., in the former case, and from 700° to 1000° in the latter. A diagram, showing the results of these observations, and the orders of the different metals in the thermo-electric series at different temperatures, was exhibited to the Section. In other experiments the effects of magnetization on the thermo-electric qualities of iron were tested. It was found that both soft iron wire, longitudinally magnetized when actually under the influence of a galvanic helix, and steel magnetized permanently in an ordinary way and removed from the magnetic influence by which the magnetic state is induced, exhibit very decided thermo-electric effects of the magnetization: in each case a thermo-electric current in metal homogeneous except as regards magnetization, could be produced with great facility; the current being always from unmagnetized to magnetized through the hot junctions. It is intended to continue the experiments to ascertain the effects of transverse magnetization on portions of a circuit of soft iron or of steel wire; and to test differences of thermo-electric properties in different directions in a magnetized mass, which the author anticipated from certain considerations more fully explained in a theoretical paper on thermo-electricity in crystals recently communicated to the Royal Society of Edinburgh. Experiments on the effects of temporary and permanent strains, by tension, and by either lateral or longitudinal compression, on various metals were described. The thermo-electric effects of temporary tension in the cases of copper and iron, which had been communicated by the author to the Royal Society in May (namely, current from stretched to unstretched through hot, in copper, and from unstretched to stretched through hot, in iron), were verified by means of a new form of apparatus so simple that he hoped to be able with great ease to test the corresponding property for a great variety of metals. In those two cases the permanent thermo-electric effects of permanent extension by drawing the wires through a draw-plate, which had been discovered by Magnus, were the reverse of temporary effects of temporary extension discovered by the author of the present paper. The thermo-electric effects produced by permanent lateral compression, always found to agree with those of permanent longitudinal extension, were tested in the cases of zinc, tin, cadmium, and lead, and were found to be the same as in the case of copper. The current was from unstrained to strained through hot in each case. Some of these results agreed, while others appeared at variance, with what might have been expected from Magnus's careful experiments; but as the author had not completed a cycle of experiments which he proposed to make on the thermo-electric effects, either temporary or permanent, of longitudinal extensions, lateral compressions, longitudinal compressions, and lateral extensions, he refrained from any further remarks on the present occasion.

On the Diamagnetic Force. By Professor TYNDALL, *Ph.D., F.R.S.*

With regard to the character of the diamagnetic force great diversity of opinion prevails. In Germany, we have Weber affirming that diamagnetic bodies possess a polarity opposed to that of iron. Weber's countryman, Von Feilitsch, combats this opinion in a series of memoirs recently published in Poggendorff's 'Annalen.' He affirms that diamagnetic bodies possess a polarity the same as that of iron; and endeavours to bring the phænomena into harmony with this view. In this country, on the contrary, we have Prof. Faraday, and it was believed, Prof. Thomson, neither of whom are prepared to admit the existence of any polarity whatever on the part of diamagnetic bodies. These divergences were a sufficient proof of the difficulty of the subject, and the necessity of caution in dealing with it; the author, therefore, thought it well to commence with the fundamental phænomena, and ascending from them to the more complicated, to endeavour to obtain, by strict adherence to experiment, a clear insight as to the real nature of that force by which certain bodies are repelled by the poles of a magnet. From an extensive series of experiments made with different bodies, and under the most diverse circumstances, the author selected a few which clearly exhibited the law according to which the repulsive force augments when the strength of the repelling magnet is increased. Were the repulsion of a diamagnetic body dependent on any constant property of the mass, then its repulsion must be simply proportional to the strength of the magnet; but it is proved by the concurrent testimony of experiments carried on in Germany, France and England, that for a wide range of magnetic power, the repulsive force increases as the square of the strength of the influencing magnet. This leads inevitably to the conclusion that the repulsion of a diamagnetic body depends, not alone on the magnet operating upon it, but upon the joint action of the magnet and diamagnet. A piece of bismuth, for example in the presence of the magnet, is thrown by the latter into a state of excitement, which varies as the magnetic strength varies, and in virtue of which the substance is repelled. The next question to be decided is, whether the state of excitement evoked by one pole, in a diamagnetic body, enables a pole of an opposite quality to repel it. To decide this, two cores of soft iron were so bent that the two semi-cylindrical ends of the cores could be placed close together, so as to form a single cylinder of the same diameter as that of the straight portions of the cores. The cores being placed in suitable helices, could be so excited that the contiguous poles were of the same or of opposite names. A bar of bismuth was freely suspended, so that both poles could act upon it simultaneously. When the cores were excited, so that the poles were alike, the bismuth was repelled; when the poles were of different names, the bismuth bar remained motionless; all action upon it was annulled. This experiment confirms those of Reich, and proves that the condition, whatever it may be, which is evoked by one magnetic pole is neutralized by the other, that each particular pole evokes a condition peculiar to itself; and here we obtain the first glimpse of the dual nature of the force under consideration. The next portion of the inquiry treated of the deportment of diamagnetic bodies when acted upon, first, by the magnet alone; secondly, by the electric current alone; and thirdly, by the current and the magnet combined. When we speak of the deportment of bismuth in any one of the cases mentioned, no exact meaning can be attached to the phrase unless it be first strictly defined in what direction, as to the planes of crystallization, the mass has been cut. A bar of bismuth, in which the planes of principal cleavage are parallel to the length of the bar, and acted upon by the magnet alone, will set itself perpendicular to the magnetic lines of force. A bar, on the contrary, in which the planes of cleavage are transverse, will set itself parallel to the solid lines. The former bar Professor Tyndall calls a normal diamagnetic bar; the latter an abnormal one. The most perfect antithesis is observed in all cases between the deportment of the normal diamagnetic bar and a bar of soft iron; the forces which cause a deflection of the former from right to left produce a deflection of the latter from left to right. If the former take up a position of equilibrium from south-west to north-east, the position taken by the latter will be from south-east to north-west; and throughout the whole experiments the same opposition of action is exhibited. By mechanical means, an abnormal magnetic bar was obtained—a bar which set its length at right angles to the line joining the poles. The abnormal diamagnetic bar shows throughout a deportment precisely antithetical to that of the abnormal magnetic one; but when we compare the normal magnetic with the abnormal diamagnetic, or the normal diamagnetic with the abnormal magnetic, the deportment is in all cases perfectly alike. It is evident, therefore, that unless the influence of structure be attended to, the greatest errors and the most inaccurate conclusions may be founded on the deportment both of magnetic and diamagnetic bodies in the magnetic field; but the thing which chiefly concerns us here is the strong presumption which the experiments justify, that whatever be the nature of the influence evoked in magnetic bodies by the action of currents, of magnets, or of both combined; to an influence of the same nature, but antithetical in its manner of distribution, the deportment of diamagnetic bodies is to be referred. The next section of the inquiry imparted clearer knowledge as to the nature of diamagnetic action. Two helices were so placed that the ends of the soft iron cores which fitted into them were about 6 inches apart from centre to centre; the helices were at opposite sides of the plane which touched the ends of the cores. A helix of copper wire was introduced, and within it a bismuth bar 6½ inches long and four-tenths of an inch in diameter was freely suspended, so that the ends of the bar were opposite to those of the soft iron cores. A current being sent through the helix, if the bismuth bar within it were excited by the current, it was probable that the nature of the excitement would manifest itself in the action of the magnets upon the diamagnetic body. By working delicately, the most perfect mastery was obtained over the suspended bismuth; when the current through the helix flowed in a certain direction, the ends of the diamagnetic bar were repelled by the electro-magnets; when the current flowing through the helix was reversed, the same ends were *attracted* by the magnets. The same effect was obtained when, instead of reversing the helix current, the polarity of the two magnets was reversed. On comparing the deflections with those of soft iron, it was found that they were perfectly antithetical. The excitement which caused the ends of the iron bar to be attracted caused the ends of the bismuth bar to be repelled, while the excitement which caused the ends of the iron bar to be repelled caused those of the bismuth bar to be attracted. All these experiments point irresistibly to the conclusion, that, whatever the ideal magnetic distribution in iron may be, a precisely opposite distribution occurs in bismuth,—or, in other words, that the diamagnetic force is a polar force, but that the polarity is the reverse of magnetic polarity. If, however, this be true, the bismuth bar, when the current circulates round it, must have its two ends in different states; but if in different states, then if we make the two poles acting upon the ends of the bar alike, we ought to have attraction at one end, and repulsion at the other,—the result of their opposing actions being that the bar must remain undeflected. This experiment has been made, and the result is in perfect accordance with the conclusion just expressed; when both magnetic poles are of the same name they completely neutralize each other. Following up this inductive reasoning, it is easy to see that if what has been stated be correct, when we bring two magnets, with poles of the same name, to bear upon the two ends of a bismuth bar, *the direction of the force emanating from the two poles being the same*, then the repulsion of one end and the attraction of the other, instead of, as in the former disposition, neutralizing each other, ought to constitute a mechanical couple tending to deflect the bar; and if two other like poles, but of opposite names to the former two, be caused to act upon the bar, the force of deflection ought to be increased. In this form the experiment was made before the Section. Four magnets were made use of; the two poles to the left were of the same name, and the two to the right were of the opposite quality. The result coincided with the author's anticipations, and the bar was promptly deflected. These experiments, without any exception, are all corroborative of the view, that diamagnetic bodies possess a polarity opposed to that of magnetic bodies,—but they do not prove that the physical theory of Weber is correct. Indeed, it is scarcely possible that his hypothesis can stand in opposition to the experimental evidence which can be brought to bear against it. One consequence of the truly beautiful theory referred to is, that when the particles of a diamagnetic body are caused to approach each other, the effect of their approximation will be to enfeeble the magnetic action along the line of approach. This view is controverted by experiment, which proves that the approximation of diamagnetic particles has an effect precisely opposite to that deduced from the theory.

Professor Tyndall exhibited experiments to show some Peculiarities of the Magnetic Field. The Professor showed that a piece of soft iron suspended between the flat poles of an electro-magnet set its longest horizontal dimension from pole, the residual magnetism of the cores being sufficient to produce the effect. This is the normal deportment of magnetic bodies, but it is by no means universal. By mechanical agency, by pressure for example, the structure of a magnetic body can be so modified that its shortest horizontal dimension sets from pole. Prof. Tyndall exhibited actions of the kind where the body operated on was compressed magnetic dust. In such a body two opposing tendencies were at work,—the tendency due to length, which sought to set the length axial; and the tendency due to structure, which sought to set the line perpendicular to the length axial. Between the flat poles the latter tendency was predominant, but between pointed poles this was not the case; here the attraction of the ends of the magnetic mass by the points constituted a mechanical couple of sufficient strength to overcome the directive tendency which was due to structure, and to draw the mass into the axial line. But in raising or lowering the body operated on out of the sphere of this local attraction, by bringing it into a position where the distribution of the magnetic field resembled that existing between the flat poles, the body forsook the axial position and turned into the equatorial. The complementary phænomena were exhibited by diamagnetic bodies. A normal bar of bismuth set its length at right angles to the line joining the poles; but Prof. Tyndall exhibited a bar of this substance, which set between the flat poles exactly as a magnetic body. Such a bar, however, between the points set equatorial. On raising it or lowering it, however, it forsook the equatorial position and set axial. In this case the local repulsion of the ends between the points caused the bar to set equatorial, the influence of length thus predominating over the influence of structure; but removed from the sphere of this local action, the directive tendency of the mass triumphed, and caused the bar to set axial. The bar in this case was cut with its length at right angles to the planes of most eminent cleavage of the bismuth:—it is a proved fact, that these planes, when the influence of form is annulled, always set at right angles to the line joining the poles, and hence where they are transverse to the length, the bar will set axial. These phænomena were examined in a great number of cases; bars were taken from substances possessing a directive tendency, and it was so arranged that the directive tendency due to structure was always opposed to the influence of length; between the points the former tendency succumbed to the latter, while between the flat poles, or above and below the points, the former was triumphant. It is amusing to observe the strife of these two tendencies in substances possessing a strong directive action. A plate of crystallized carbonate of iron, when properly suspended, will wrench itself spasmodically from one position into the other, and find rest nowhere. The simple law which governs all these actions is, that if the body, cut as above, be diamagnetic, its length sets equatorial between the points, but above and below them axial. If the body be magnetic, it sets axial between the points, above and below equatorial. Hence the rotation of a magnetic body, on being removed from between the points, is always from axial to equatorial; while the corresponding rotation of a diamagnetic body is always from equatorial to axial. The deportment of wood in the magnetic field was next described. Nearly sixty specimens examined by Prof. Tyndall were all diamagnetic; all of them were repelled by the poles of the magnet; cubes of each, when suspended with the woody fibre horizontal, set, between the excited poles, with the fibre perpendicular to the line which unites the poles. Thinking that wood, on account of its structure, would exhibit those directive phænomena which had been demonstrated in the case of the bodies mentioned at the commencement, bars were taken from nearly forty kinds of wood, the fibre being at right angles to the length of the bar; in the centre of the space, between two flat poles, all those bars set their lengths from pole to pole. But Prof. Tyndall afterwards observed the remarkable fact, that homogeneous diamagnetic bodies did the same. Bars of sulphur, of salt of hartshorn, of wax, and other diamagnetic substances, when suspended in the centre of the space between two flat poles, set their lengths from pole to pole. Now, as diamagnetic bodies always take up the position of weakest force, it was proved by these experiments, and corroborated by others not cited here, that the line joining the centres of two flat poles, contrary to the general opinion hitherto received, was the line of minimum force.

On Improvements in Submarine and Subterranean Telegraph Communications. By C. F. VARLEY, *London.*

The inventor explained experiments he had made with gutta percha covered wires, varying from 30 to 1500 miles in length, and showed an enlarged diagram, the original of which was drawn by the electric currents themselves decomposing solutions of ferrocyanide of potassium and nitrate of ammonia, with which the paper was saturated. These experiments showed, that the electric current did not appear *suddenly* at the extreme end; but the wire becoming charged by induction, like a Leyden jar, the current commenced gradually and did not reach its maximum power through 1500 miles of wire until seven seconds of time had elapsed, and continued flowing out seven seconds after contact with the battery had ceased; that with the ordinary telegraph systems such a wire would require fifteen seconds of time to make each signal, and as several signals are required for a letter, only one average word could be transmitted per three minutes. Mr. Varley showed, that with the submarine and subterranean wires between Holland, London, Liverpool, and elsewhere, the Baines and Morse's instruments would only work at speeds too slow for commercial purposes; but that by aid of his apparatus these wires are now and have been for six months working at the required speed, viz. twenty-five words per minute, for which 300 alternations of current per minute are required. The effects of the former two telegraphs with these wires when working fast is to run all the marks together, because the first electric impression has not ceased when the second is given; but his apparatus, by spilling the charge and reversing the current at every move of the key, produces rapidly alternating currents through the wire, which, though very weak at the extreme end of the wire, are quite sufficient to actuate his galvanometer relay, which actuates a *local* battery to produce the marks. The little arm on the axis of the relay, instead of striking against a dead stop, rubs obliquely against a gold spring, filing off the little film of air which otherwise would prevent the instant completion of the local circuit; gravity also is made to assist this contact. So sensitive is this apparatus, that four elements of a copper and zinc battery have been found sufficient to work from Manchester to London. He added, "Its advantages over the needle systems are,—it requires only one wire, gives a printed record of all communication, requires but one-fourth the power to actuate it, and is not interrupted by a comparatively defective insulation. It gains these advantages:—1st. By discharging the line-wire between every move of the key. 2nd. Gravity aiding electricity in making the relay contact, thus using the sun instead of the difference of the forces. 3rd. The sliding action of the relay contact, by rubbing off the thin film of air, gives sure and instant contact with a very small amount of battery power. 4th. It will work through a very considerable amount of leakage from one wire to the other, because there is a current always flowing through the wire, rendering this apparatus peculiarly adapted for wires suspended in the air, and which leak from one to the other in damp weather, the surfaces of the intended insulators becoming coated with moisture."

After dismissing the mechanical difficulties of laying a cable between England and America, he stated, "I have come to the following conclusions:—1st. If a wire could be suspended in an unbounded non-conductor or atmosphere with no conducting body near it, the transmission of an electric current through it would be instantaneous, no matter what the length of wire. 2nd. The approach of any conducting body to this wire would (by induction) reduce the speed of the transmission as shown in the 1500-mile experiment. 3rd. In the case of a wire coated with a non-conducting substance (such as gutta percha), the induction decreases in the same proportion as the thickness of the coating is increased. 4th. The conducting power of a wire is in proportion to its substance, the induction in proportion to its surface."

He then calculated the dimensions of a cable 3000 miles in length, which would transmit twenty-five words per minute. "A copper wire one-sixth of an inch in diameter, coated with gutta percha to the depth of nearly half an inch, would be found capable by aid of my apparatus of transmitting twenty-five words per minute 3000 miles; to work the ordinary telegraphs the copper wire must be three-eighths of an inch in diameter and coated with gutta percha three-fourths of an inch, making a total diameter of about 2 inches."

Mr. Varley's apparatus has been in use six months, both by the Electric Telegraph and International Telegraph Companies.

Notice of some Experimental Researches into the Application of the Voltaic Battery to the Ignition of Gunpowder. By Capt. WARD, *R.E.*

Capt. Ward having been requested by Sir John Burgoyne, Inspector-General of Fortifications, to carry out some experiments for determining the best form of voltaic battery for military purposes, he made himself fully acquainted with the labours of Ohm, Wheatstone and others, and, whilst verifying many of their theoretical researches, made them the bases for his own inquiries. After a most careful comparison of several batteries, he adopted a Grove's battery, the solid elements being zinc and platinum, and the liquid nitric acid and dilute sulphuric acid; and he finally ascertained that plates, only 2 inches square, were, perhaps, the most satisfactory as regards work and cost. These he arranges in small elementary batteries of six pairs, which, with the containing box, occupy a space of only 7 inches long, 4 inches wide, and 4 inches deep, so that eight or nine of these elementary batteries, capable of igniting gunpowder at the greatest distances likely to be required for military purposes, would be arranged in a space of 1′ 2″ by 1′ 4″ or 1′ 9″ by 1′ 4″. In carrying out his experiments, and especially in determining the relative value of each form of battery and the effect of any modification of the battery or of the conducting wires in respect to the calorific effect, Capt. Ward found that the deflection of the needle of the ordinary galvanometers was so great as to render it unfit for the estimation of differences in the electrometric force in such powerful currents; and he therefore constructed a very simple instrument, by which he is enabled to interpose one, two, or more pieces of thin platinum wire in the circuit; and, using this instrument, in conjunction with Prof. Wheatstone's rheostat, to determine the relative force of any battery, as well as the resistance of the platinum wire itself, by the calorific effect exhibited on the fusion of the platinum wire. These researches are now preparing for publication in the Professional Papers of the Corps of Engineers, and are, in fact, going through the press; but Lieut.-Col. Portlock thought it desirable to make known to the Section these first labours of a most talented young officer, who has been already appointed to the responsible post of Master of the Australian Mint. He was first recommended by Major-Gen. Lewis as a person highly fitted to conduct the electrical experiments, and commenced them under his direction at Portsmouth; but he soon passed far beyond the simple experiments then projected, and has rendered his researches not only valuable as a scientific work, but important as an example of assiduous study and careful experiment to his brother officers.

ASTRONOMY.

New Observations on Solar Spots and Fæculæ, and their true Causes. *By* M. CHACORNAC. (*Communicated by the* Abbé MOIGNO.)

M. Chacornac considers the solid body of the sun to be surrounded with a luminous envelope extending to a short distance, as well as by an atmosphere which at lower parts, or those next to the luminous envelope and body of the sun, is very dense: detached clouds or other bodies floating in this atmosphere when they are light enough to float outside and beyond the luminous envelope, constitute spots, and can be shown to be capable of exhibiting all their usual phænomena; while those which are dense enough to descend into the luminous atmosphere constituted fæculæ; those lower still were hidden from view by the brilliancy of the luminous envelope.

On Meteorolites and Asteroids. *By* Mr. GREG.

The author brought forward some circumstances in connexion with those bodies, not hitherto noticed, in favour of the theory that they are identical in nature and origin. After stating some arguments against the theory of the atmospheric origin of aërolites, Mr. Greg proceeded to give an abstract of some results he had lately obtained in analysing a very complete catalogue of aërolite falls. It would appear that since the year 1500 A.D. there are 179 authenticated instances of falls of aërolites, the month of whose fall is known; the number for each month being as follows:—For January, 10; February, 15; March, 17; April, 14; May, 15; June, 18 falls,—first half of the year, 89 falls; July, 19; August, 15; September, 17; October, 14; November, 15; December, 9 falls,—second half, 89 falls; giving an average of 15·0 for each month. The most important thing to notice is the small number of aërolites registered for the months of December and January, and the comparatively large number for June and July; the former two showing but 19 instances of falls, the latter two 37, or almost double. Now, granting that these aërolites, or meteorolites, belong to the system of the Asteroids, having orbits therefore whose mean distance is superior to the earth's orbit, it is certainly reasonable to conclude that it is when the earth is furthest from the sun, *i. e.* at her aphelion, that the meeting with aërolites is rendered most probable. This is what would really appear to be the case, for the earth is at her greatest distance from that luminary on the sides of the summer solstice, *i. e.* in June and July, precisely the months shown to be most abundant in aërolites. Mr. Greg then referred to a recent number of the 'Comptes Rendus,' in which there is a paper by Le Verrier on the asteroids. M. Le Verrier shows by calculation that the sum of the mass of the fragmentary planets called asteroids cannot exceed one-fourth of the earth's mass; and also shows it probable that their mean mass or system is at its perihelion, and consequently nearest the earth, at the time when the earth herself is on the side of the summer solstice. This would appear again confirmatory of the theory that aërolites are the minute outriders of the asteroids. There would appear to be also further evidence, though of another kind. It has been supposed that some of the larger asteroids have irregular and angular surfaces, which is precisely the case with the majority of the meteoric stones which fall to the earth. Again, taking the average specific gravity of aërolites at 3·0 (they vary from 1·7 to 3·9), further indirect evidence is afforded as to their position with regard to distance from the sun, and, taking water as 1·0, the following table shows the relative densities of several of the planetary bodies, following the order of their distances from the sun: Mercury, 15·7; Venus, 5·9; Earth, 5·6; Mars, 5·2; Aërolites, 3·0; Asteroids, (?); Jupiter, 1·4. Another circumstance relating to aërolites which was alluded to by Mr. Greg, was the periodicity of those bodies, and he mentioned more particularly the 19th of May, 29th of November, 13th of December, 15th to 19th of February, and 26th of July, as being aërolitic epochs, aërolite falls having been recorded on the following days:—February 3, 10, 10, 13, 15, 15, 15, 18, 18, 18, 19, 19, 25, 27, 27; May 9, 10, 17, 17, 17, 18, 19, 19, 20, 22, 26, 26, 27, 28; July 3, 3, 4, 7, 8, 12, 14, 17, 18, 22, 24, 24, 26, 26, 26, 30; November 5, 7, 11, 13, 17, 20, 23, 25, 27, 29, 29, 29, 29, 30, 30; December 11, 13, 13, 13, 13, 13, 14, 25, 28. In referring, however, to the epochs most remarkable for the periodical displays of luminous meteors, as November and August 9th to 14th days, Mr. Greg observed that the number of aërolites recorded as falling on those days is remarkably small, indeed under the average of the year, for out of 165 falls (the day as well as month of fall being known), but four have fallen between the 9th and 14th days of August and November. The aërolitic and (luminous) meteoric epochs also would appear to differ, with the exception of the 29th of November. From this circumstance it seems probable that aërolites, and the majority of luminous meteors (especially periodic and conformable ones), are resolvable into separate classes; and in corroboration of this it may be mentioned, that, while the number of aërolites whose falls have been recorded are about equally divided for the first as for the second half of the year, this is very far from being the case with luminous meteors, by far the larger numbers of which are observed during the second half of the year, viz. from July to December. While, then, we consider aërolites as belonging to asteroids, with orbits superior to the earth's, and partaking of the nature of true though minute planets, the majority of luminous meteors may be considered as having characters more in common with comets. It has been shown by several astronomers, as Olmsted, Pierce, Erman, and others, that the majority of periodic meteors have orbits inferior to the earth's, and their perihelia near the planet Mercury. Mr. Greg concluded, after making some observations in favour of the self-luminosity of meteors, by suggesting the probability of their having a nature less dense than that of aërolites, but denser than that of comets, and that it is not improbable they have a fluid or viscid nature.

On the Variation in the Rates of Chronometers.
By JOHN HARTNUP, *F.R.A.S., Liverpool.*

At the meeting of the British Association in this town in 1837, a Memorial from that body, on the subject of a nautical observatory, was read before the Town Council, and referred to a special Committee. It is stated in the Memorial that "among the various objects of interesting inquiry which have been brought before the British Association at their visit to this large and enterprising commercial town, is the condition of nautical astronomy in the merchant service—a science, the application of which is decidedly the most important to mankind. The loss of life and property which is annually caused by a defective knowledge of this science would astonish, were it publicly known." After urging the importance of erecting a nautical observatory, the objects of such an establishment in a port like this are said to be the "accurate knowledge of Liverpool time, and the care of chronometers while in port, so that a captain when he sails may receive his chronometers, sure both of their error and rate, which at present he cannot do. In this the Committee have no intention of disparaging the chronometer-makers of Liverpool, for it is stated that even in London the times obtained from celebrated makers have differed two minutes, and these two minutes might have caused a wreck." I have quoted the above extracts in order to show that hopes were entertained of an improvement being effected in navigation by having recourse to more accurate means of rating and testing the quality of chronometers employed in the merchant service. In accordance with the wishes expressed in the memorial the corporation established a first-rate nautical observatory. This observatory has now been in operation, so far as regards the rating and testing of chronometers, for nearly ten years; and the very active part taken by the British Association in the recommendation of its establishments at its first visit to this town leads me to hope that an equal degree of interest will be taken at this, its second visit, in the results of our labours. As regards the purely scientific department, the observations have for the most part been printed, and the liberality of the corporation in supplying the observatory with the magnificent instruments with which these observations were made, will, I doubt not, be highly appreciated by the distinguished visitors now in this town. There is, however, one department of the observatory to which public attention has not been directed so fully as, I think, its importance deserves—I allude to the rating and testing of chronometers; this being, moreover, the main object for which the observatory was established. In the Memorial from which I have quoted, it is stated that a captain could not at that time obtain the correct error and rate of his chronometer, in consequence of the time not being accurately known. Since the establishment of the observatory, this deficiency has been removed; the arrangements for obtaining and carrying on the time are so complete that no sensible error can possibly arise in that way. Having accomplished this object, our attention has been directed to further improvements; and the exquisite arrangements which we possess for testing time-keepers, have led us to the discovery of a source of error, to which chronometers employed in the merchant service are subject, the importance of attending to which I will endeavour to explain. To enable the mariner to find his longitude at sea by the chronometer, he is furnished with its daily gain or loss, which is called its *rate*. The practice almost universally adopted has been to take for granted that this rate is uniform during the voyage. Chronometers are supposed to be compensated for the changes of temperature to which they must necessarily be exposed at sea in different latitudes, and captains are instructed to use the same rate in all climates. Now, we are prepared to show that, for chronometers employed in the merchant service, the average change of rate caused by changing the temperature from 40° to 60° Fahr. is *seven seconds* a day. Hence, if we ascertain the rate of a chronometer on shore with the most scrupulous degree of accuracy, in a temperature of 40°, and this chronometer be afterwards taken to sea and exposed to a temperature of 60° for the short period of eighteen days, the accumulated error on Greenwich time, according to the above-named average, will be upwards of two minutes, and an error of two minutes it is stated in the Memorial before referred to might cause a wreck. This variation of rate, from change of temperature, differs so much in different time-keepers, that without a trial no idea can be formed of its amount in any particular chronometer. In order to show this more clearly, we have compiled, from the records of the observatory, three tables; each table shows the change of rate for each of one hundred chronometers, caused by changing the temperature to the extent named in the respective headings. Notwithstanding the great change of rate (shown by the tables to have been produced by change of temperature), we find that in nineteen cases out of twenty the original rates return the instant that the original temperature is restored. On an average of about one chronometer in twenty, it is found that the rate changes in the most capricious manner with almost every change of temperature; and an examination of our records will show that the sea-rates of such chronometers are equally uncertain,—no dependence whatever can be placed on them. Such imperfect time-keepers have necessarily been rejected in forming the tables, but in other respects the chronometers were taken in succession as they were presented at the observatory. They are arranged in the order of change of rate, beginning with the chronometer which gained the most, and ending with that which lost the most. In Table I., the average change in the daily rate caused by changing the temperature from 40° to 60° is 6″·97; taking the two extremes, one chronometer in the hundred gained 15″·3, and one lost 72″·2 a day, by changing the temperature only 20°; the average change of rate of the first ten in the hundred is 7″·1 gaining; the average of the second ten is 0″·3 losing; and the average of the last ten in the hundred is 29″·8 losing. There are fifteen chronometers in which the loss is more than 4″ and less than 5″ a day, and there are six in which the loss is more than 8″ and less than 9″ a day; so that it is quite possible for a captain to have two or three chronometers, all of which might place the ship in nearly the same longitude, and this longitude might, notwithstanding, by the accumulated errors of the chronometers in two or three weeks, be wrong to an amount sufficient to place the ship in danger. Tables II. and III. show the change of rate caused by changing the temperature from 60° to 80° and from 50° to 80° respectively; the variations, it will be seen, were much greater in the low than in the high temperatures. It appears, as before stated, that about 5 per cent. of the chronometers which have passed through the observatory are altogether unfit to be used for nautical purposes. With the means which we possess for testing, there is no difficulty in detecting such chronometers in a trial of two or three weeks. With regard to the remaining 95 per cent., it appears that very great dependence may be placed on them if we take into consideration the change of rate due to change of temperature. Unfortunately, we have no record of the temperature to which the chronometers that have passed through the observatory have been exposed during the voyage; but we find that the average of the sea-rates of chronometers employed in the North American trade agrees with the rates of the same chronometers on shore in a temperature of about 60°, and that the average of the sea rates of chronometers which have been exposed to a tropical climate during great part of the voyage, agrees with the rates of the same chronometers on shore in a temperature of about 80°. The regularity with which we find this to take place is such as to leave no doubt as to the advantage which an intelligent navigator would derive by correcting the rate of an imperfectly compensated chronometer for change of temperature when the voyage is long and the climate changeable. Captains, however, have never been instructed to do this; such a method of proceeding forms no part of their education; and even in the examination which all are now compelled to undergo before they take the command of a ship, their attention is not even drawn to the possibility of the rates of chronometers being affected by change of temperature. The rates, as before stated, are assumed to be uniform in all climates. The different owners of the 300 chronometers, the variable rates of which are shown in the tables, were made acquainted with this imperfection for the first time when they sent their chronometers to the Liverpool Observatory. I am not aware of the existence of any other establishment in the world in which captains of merchant ships can obtain any information relative to the variation of the rates of their chronometers in different temperatures. Attention appears to have been exclusively directed to accurate astronomical means of determining the rate. Now, our records show that the average variation of rate caused by changing the temperature so small a quantity as one degree of Fahrenheit, is very much greater than the probable error in the rate arising from any imperfection in our astronomical means of determining it. If we assume the rate to be affected by no other cause, the variation arising from change of temperature is so great, that unless we take it into account, the agreement between the land and sea-rate must be the result of mere accidental coincidence, and practically this is found to be the case. Professional raters make themselves acquainted with the sea-rates of the various chronometers which pass through their hands, and then adapt the shore-rates to them. The cause of this variation between the shore and sea-rate is generally supposed not to be known. The duty of finding out the amount of variation by collecting and discussing the sea- and shore-rates is confided to the professional rater, and captains are kept in ignorance of its existence; so that a change of temperature may at any time be the cause of the chronometer deceiving both the rater and the captain. That serious disasters do occasionally occur from this cause there cannot be a doubt; and it is quite certain that they might be avoided, either by captains being made acquainted with the variation of rate peculiar to each of their chronometers, or by makers removing the fault by effecting a more perfect compensation. With respect to the former method, our records show that in an observatory provided with the necessary apparatus, it is quite practicable to ascertain the variation of rate due to change of temperature, and to supply captains with the means of making the correction. With regard to the latter, the attention of chronometer-makers has been directed to the subject for many years; numerous methods have been patented professing to effect a more perfect compensation, and we find, by the published rates of the chronometers, which are now sent to Greenwich annually for trial, that three-fourths of them are said to have some improvement intended to remove this serious defect. Now, what is the effect of all this upon chronometers employed in the merchant service? We need only to appeal to the results shown by the tables which I now present for an answer: they show how excessively those chronometers lose at the two extremes of temperature, and instead of three-fourths, as at Greenwich, having some improvement, we find the ordinary imperfect method of effecting the compensation almost universally had recourse to. The practice adopted by makers of applying their improvements to chronometers intended for the navy, and not applying them to those intended for the merchant service, has doubtless arisen from the knowledge, that in the former they would be tested at the Greenwich Observatory previous to their being purchased; while in the latter, captains and those about to purchase chronometers have, till lately, had no means of testing them, or making themselves acquainted with the advantage of any improvement in the compensation; and now that this great boon is offered them in Liverpool, through the liberality of the corporation, the advantage to be derived from it is so little understood that but comparatively few avail themselves of it. If some method could be devised of disseminating knowledge on this subject amongst captains, shipowners, and underwriters—all of whom are deeply interested in a quick and secure passage—surely some means would be taken for testing all chronometers in those temperatures to which ships are liable to be exposed at sea previous to their being placed in the hands of captains. By so doing, navigation would be greatly facilitated and rendered much more secure; and the best method of accomplishing this object is, I think, a subject well-worthy of the consideration of the British Association; for it will be found that we are in possession of most undoubted evidence that the rates of chronometers now employed in the merchant service are so much affected by change of temperature as to render them very unsafe, and even dangerous instruments, in the hands of captains who are unacquainted with the facts which I have so imperfectly developed in this brief notice. We therefore entertain the hope that more efficient and systematic efforts will speedily be made to diffuse the requisite information amongst all those who are personally or otherwise interested in these important matters, which I have now presumed to bring under the notice of the British Association.

TABLE I.

Showing the change in the daily rate of each of 100 Chronometers, caused by changing the temperature from 60 to 40 degrees.

Reference No.	Increase of gaining-rate by changing the temperature from 60 to 40 degrees.	Reference No.	Increase of gaining-rate by changing the temperature from 60 to 40 degrees.	Reference No.	Increase of gaining-rate by changing the temperature from 60 to 40 degrees.	Reference No.	Increase of gaining-rate by changing the temperature from 60 to 40 degrees.
	s		s		s		s
1	+15·3	26	−1·9	51	−3·7	76	− 6·2
2	13·1	27	2·0	52	3·8	77	6·3
3	8·1	28	2·2	53	4·0	78	6·5
4	7·9	29	2·3	54	4·1	79	6·8
5	7·8	30	2·3	55	4·2	80	7·0
6	5·4	31	2·3	56	4·3	81	7·3
7	4·4	32	2·4	57	4·3	82	8·1
8	3·8	33	2·4	58	4·3	83	8·2
9	3·2	34	2·9	59	4·5	84	8·5
10	1·9	35	2·9	60	4·5	85	8·6
11	1·0	36	2·9	61	4·5	86	8·7
12	0·6	37	3·0	62	4·6	87	8·8
13	0·3	38	3·0	63	4·6	88	9·0
14	+ 0·1	39	3·1	64	4·8	89	9·0
15	− 0·8	40	3·1	65	4·8	90	9·1
16	1·0	41	3·1	66	4·9	91	9·6
17	1·1	42	3·2	67	4·9	92	10·8
18	1·2	43	3·2	68	5·0	93	11·1
19	1·4	44	3·3	69	5·1	94	12·0
20	1·5	45	3·3	70	5·3	95	21·5
21	1·6	46	3·3	71	5·3	96	22·7
22	1·7	47	3·4	72	5·8	97	28·1
23	1·9	48	3·5	73	6·0	98	45·2
24	1·9	49	3·7	74	6·1	99	65·1
25	− 1·9	50	−3·7	75	−6·1	100	−72·2

Average change of daily rate 6·97 seconds.

TABLE II.—Showing the change in the daily rate of each of 100 Chronometers, caused by changing the temperature from 60 to 80 degrees.

Reference No.	Increase of gaining-rate by changing the temperature from 60 to 80 degrees.	Reference No.	Increase of gaining-rate by changing the temperature from 60 to 80 degrees.	Reference No.	Increase of gaining-rate by changing the temperature from 60 to 80 degrees.	Reference No.	Increase of gaining-rate by changing the temperature from 60 to 80 degrees.
	s		s		s		s
1	+13·1	26	−1·2	51	−1·9	76	− 3·0
2	7·1	27	1·2	52	2·1	77	3·0
3	6·2	28	1·2	53	2·1	78	3·0
4	5·5	29	1·3	54	2·1	79	3·2
5	4·8	30	1·3	55	2·1	80	3·3
6	4·1	31	1·3	56	2·2	81	3·3
7	3·8	32	1·3	57	2·2	82	3·3
8	3·8	33	1·4	58	2·3	83	3·5
9	3·5	34	1·5	59	2·3	84	3·6
10	3·4	35	1·5	60	2·3	85	3·6
11	3·1	36	1·6	61	2·3	86	3·7
12	3·1	37	1·6	62	2·3	87	3·7
13	2·6	38	1·6	63	2·4	88	3·7
14	2·4	39	1·6	64	2·5	89	3·8
15	2·0	40	1·6	65	2·6	90	3·8
16	1·9	41	1·7	66	2·6	91	3·9
17	1·5	42	1·7	67	2·6	92	4·0
18	1·3	43	1·8	68	2·6	93	4·1
19	1·3	44	1·8	69	2·7	94	4·1
20	+ 1·1	45	1·8	70	2·7	95	4·2
21	− 0·6	46	1·9	71	2·8	96	4·6
22	0·7	47	1·9	72	2·8	97	4·7
23	0·8	48	1·9	73	2·9	98	5·3
24	1·0	49	1·9	74	2·9	99	5·5
25	− 1·1	50	−1·9	75	−3·0	100	−12·0

Average change of daily rate 2·85 seconds.

TABLE III.—Showing the change in the daily rate of each of 100 Chronometers, caused by changing the temperature from 50 to 80 degrees.

Reference No.	Increase of gaining-rate by changing the temperature from 50 to 80 degrees.	Reference No.	Increase of gaining-rate by changing the temperature from 50 to 80 degrees.	Reference No.	Increase of gaining-rate by changing the temperature from 50 to 80 degrees.	Reference No.	Increase of gaining-rate by changing the temperature from 50 to 80 degrees.
	s		s		s		s
1	+14·2	26	+2·4	51	+0·3	76	−2·0
2	9·7	27	2·3	52	0·2	77	2·0
3	7·9	28	2·2	53	+0·1	78	2·1
4	5·8	29	2·1	54	0·0	79	2·1
5	5·3	30	2·0	55	−0·1	80	2·1
6	5·1	31	2·0	56	0·2	81	2·1
7	4·3	32	2·0	57	0·3	82	2·3
8	4·0	33	1·9	58	0·4	83	2·6
9	3·8	34	1·9	59	0·4	84	2·7
10	3·5	35	1·8	60	0·5	85	2·7
11	3·5	36	1·6	61	0·6	86	2·8
12	3·4	37	1·6	62	0·6	87	2·8
13	3·3	38	1·5	63	0·7	88	2·8
14	3·3	39	1·5	64	0·8	89	2·9
15	3·3	40	1·5	65	0·8	90	3·0
16	3·2	41	1·5	66	1·0	91	3·1
17	3·0	42	1·2	67	1·3	92	3·3
18	3·0	43	1·0	68	1·4	93	3·5
19	2·9	44	0·8	69	1·5	94	3·6
20	2·7	45	0·8	70	1·6	95	3·6
21	2·6	46	0·7	71	1·7	96	3·8
22	2·5	47	0·5	72	1·9	97	4·3
23	2·4	48	0·5	73	2·0	98	4·7
24	2·4	49	0·5	74	2·0	99	5·5
25	+ 2·4	50	+0·4	75	−2·0	100	−8·5

Average change of daily rate 2·49 seconds.

Notes on the British Association Catalogue of Stars.
By W. S. Jacob, *Director of the Madras Observatory.*

The catalogue of 8377 stars published by the Association in 1845, though compiled from the best data available at the time, is, as regards the places of many southern stars, erroneous, owing to the imperfect nature of the data, especially those depending on Lacaille and Brisbane.

A thorough revision of the catalogue was therefore commenced at Madras in 1849, and completed in 1853, by observing, in most cases, at least three times with both transit and mural circle, every number to which any doubt attached between the N. P. D. 40° and 155°, and in a few cases a little beyond these limits.

The subsidiary catalogue thus formed has been printed in the last volume of 'Madras Observations,' which should ere now have been on its way to the India House.

The general results of the revision may be briefly stated as follows:—In all, 1503 numbers were examined; of these the undermentioned 55 were missing, viz.:—

186
278
434
534
601 dup. of 596?
642
931
935
969
2018
2686
3233
3328 dup. of 3323?
3401
3454
3461
3482
3535
3586
3707 dup. of 3706?
4399
4569
4983
5025
5162
5241 dup. of 5247?
5349 dup. of 5350?
5415
5482
5491
5524
5662
5665
5672
5685
5707
5725
5738
5741
5770 dup. of 5772?
5816 dup. of 5815?
5849
5923
5928
6542
6725
6770
6775
6898
6917
7203 dup. of 7210?
7214 dup. of 7225?
7467 dup. of 7466?
7576 dup. of 7575?
8042

Twelve numbers marked as Nebulæ were examined, viz.:—

2511
2766
3247
3547
3692
3944
4485
5040
5300
5470
6201
7457

and were found to be clusters of small stars, 5 of which contained a star sufficiently conspicuous to be identified, and were therefore included in the catalogue; but the remaining 7 were of necessity omitted.

The places of 1440 numbers were recorded; 71 of which were found to differ from the B. A. Catalogue by more than 2^s of R. A., or $10''$ of P. D., and 29 more in which the difference was between 1^s and 2^s. Of these 17 are accounted for as mistakes of gross quantities, such as 1^m &c. of R.A., or $10'$ &c. of P. D.

With the above exceptions, the agreement of the observed places with the Catalogue is in general very close, and in the cases of those stars which depend upon Groombridge, remarkably so.

The proper motions assigned in the Catalogue have been in some cases confirmed; but as regards most of the southern stars, they have been either negatived or rendered doubtful, and the question must therefore stand over to be decided by future observations.

On Micrometrical and Photographic Drawings of the Lunar Surface.
By John Phillips, *M.A., F.R.S., F.G.S.*

The author presented drawings of parts of the moon by Prof. Challis, Prof. P. Smyth, and himself, photographic representations from his own telescope, and the achromatic of the Liverpool Observatory—and other light pictures communicated for the occasion by Dr. Lee and Mr. Nasmyth. He called attention in particular to three large drawings of the Mare Crisium, after sunrise on that part of the lunar surface, at mid-day on the same, and before sunset, executed by Prof. Smyth; and to diagrams of Plato and the regions around it by Prof. Challis. In commenting on the results of the labours of the Committee during the past year, Prof. Phillips drew attention to the methods employed by Prof. Smyth and Prof. Challis, which combined instrumental measures, eye sketches, and finished designs, and presented the varied aspects of the lunar surface, depending on the angle of illumination which had been expressly indicated by the Committee. He remarked on the continually growing exactness with which the telescope was applied to the delineation of the lunar scenery, which, to inferior instruments appearing smooth and even, revealed itself to more powerful scrutiny as altogether uneven, mostly rugged land, deeply cut by chasms, and soaring into angular pinnacles. The so-called seas, under this scrutiny, appear destitute of water, and their surface, under low angles of incident light, becomes roughened with little points and minute craters, or undulated by long winding ridges of very small elevation, comparable to the gravel ridges of Ireland and Scandinavia. On the question thus and in other ways raised for discussion, whether the moon, now devoid of water on the face she presents to us, contains traces of ancient watery movement, Prof. Phillips called attention to the numerous straight rifts and winding "Rillen," as the Germans call them, which, to clear telescopes only, reveal themselves in many tracts of the lunar land. One of them, Mare Nubium, is really a fault line, 45 miles long, the vertical movement greater at one end than the other—others cross several craters diametrically—some are rugged ravines—many only a few hundred feet across. And turning to Gassendi, the mountain which, in connexion with Mare Humorum, had been allotted to himself for his survey, he described its long encircling wall, broken through towards Mare Humorum, duplicate in one part, crossed by three deep narrow clefts in another, and partly interrupted by a great oval crateriform appendage, which is broken down or deficient on the side against the great crater of Gassendi. Here, concentrating to, or diverging from, the smaller crateriform appendage, are seen, but only with good instruments, many branching ridges and hollows, whose stems are towards the small crater, and whose extremities reach towards the mountains in the middle of Gassendi. If these are branching tracts of volcanic matter poured out from the smaller crater, their slope will be from it; if they be due to alluvial action, their slope will be towards it; and this is a test which perhaps can be accurately applied in this situation, by carefully delineating the shadows which fall in morning and evening from the lofty walls of the crater.

In speaking of the progress made by himself since the meeting in 1854, and by the Committee and the Liverpool Photographic Society in obtaining light-pictures of the moon, he remarked as of good augury, in his own case, the acceleration of the process, so that 30″ were now more than sufficient for a 2-inch picture, while 300″ were employed in 1853 on a picture only 1½ inch across. The Liverpool photographers had now obtained many good pictures, and had been successful in enlargements by daylight.

Attention was further called to the augmented blackness in the photography of certain shadows of the moon, and the fidelity with which the relative brightness of the mountains and radiating light spaces were rendered in them—circumstances of importance, as likely to lead hereafter to some good idea of the reflecting power and other peculiarities of the lunar surface.

Researches in Meteoric Astronomy.

By DANIEL VAUGHAN, *Cincinnati, Ohio.*

Astronomical observations have lately furnished grounds for the opinion that the planets do not revolve in an absolute vacuum, and that they cannot, therefore, exist for ever in their present condition. Every return of Encke's comet brings intelligence of a rare medium disseminated through space; but I think that more reliable indications of this subtle fluid may be derived from its effects on the orbits of small meteors which are now recognized as members of the solar system. In traversing any fluid with the same rapidity, spheres of different magnitudes sustain a diminution of velocity inversely proportional to their densities and their diameters; and the orbits which they might describe around the sun, in such circumstances, should change in a corresponding degree. If an eight-inch iron ball moved in the path the earth now describes, there should be a greater reduction in the magnitude of its orbit after two years, than the earth's orbit could experience in one million centuries. Very small meteors or shooting stars are, therefore, extremely sensitive to effects of a resisting medium; and they seem well calculated to serve as a test of the perfection of the vacuum in the celestial spaces.

This delicate test would be unavailable were it not for the translatory motion of our system, and the great eccentricity of the orbits which meteors describe. Whenever the size or density of these bodies is so small that they are much more sensitive to the resistance of the medium than they are to planetary attraction, the planes of their orbits must be gradually brought into a coincidence with the track which the sun describes through space. The transverse axes of their orbits will also tend to assume a determinate position. If their velocity be impeded by the medium while they approach the sun, the lines of apsides will advance in the direction of their orbital motions; but this apsidal change will be reversed by any similar impediment which they may receive while retiring from the central luminary. These opposite effects neutralize one another when the transverse axes of the meteoric orbits are perpendicular to the line of the sun's translatory motion. By this arrangement also the influence of the medium in diminishing gravity on one side of transverse axes should become just adequate to counterbalance the effects arising from its augmentation of gravity on the opposite side. The orbits of the smallest meteors must, therefore, have their transverse axes, in most cases, located near a plane perpendicular to the sun's track. In their perihelia these bodies must necessarily move, either in the same direction as the sun, or take an opposite course. In the former case, their orbits should continually diminish in eccentricity, and finally become indifferent to the control of the medium on their position: in the latter case, their orbits will become more eccentric, and have their transverse axes confined to a more limited range.

The influence of planetary attraction on orbits of this character is much circumscribed, and it can only change the position of their planes by turning them about the line of the solar motion. If the planets all moved in the ecliptic, their action should ultimately bring into this plane the transverse axes of most of the ellipses which meteors describe; and this change would be permanent, not periodical. Immense swarms of these small bodies should, therefore, be congregated into a vast zone extending in the direction of the sun's motion, and intersecting the ecliptic about 90° from the point in space to which he is advancing. In this manner we may account for the origin of the meteoric zone, through which the earth passes on the 10th of August. It is evident that the action of the planets in causing this arrangement is far more effective when the motion of the meteors is direct than when it is retrograde; and, for this and another reason previously noticed, no remarkable appearance of shooting stars could be expected in the opposite part of the ecliptic.

The great falls of shooting stars which sometimes occur on the 12th and 13th of November, seem to indicate the existence of another meteoric zone perpendicular to the one just noticed, and to the ecliptic; and its origin may be ascribed to the small influence of the planets in deflecting meteors occupying this region from the planes in which they move. The zone which the earth crosses on the 8th and 10th of August, seems to contain far the larger collection of these small and light bodies; but as the earth passes through the central regions in which they are least abundantly congregated, the appearance of shooting stars on these nights can give no adequate idea of the immense swarms of meteors encircling the sun. There is also much reason to believe that the innumerable host of meteors in this zone reflect a considerable portion of the solar rays, and thus cause the phænomenon of the *Zodiacal Light;* but I can regard these bodies as eternally self-luminous while wandering in space. I have shown in another place that the light which they emit on visiting the earth, arises from the great pressure they impart to the luciferous atmosphere of our planets; and that the compression of a similar atmosphere by the sun's powerful attraction causes his perpetual brilliancy.

TIDES.

On Mr. Superintendent Bache's *Tide Observations.*

By the Rev. WILLIAM WHEWELL, *D.D., F.R.S.*

In the earlier part of my researches of the tides, of which an account has been given to the British Association on various occasions, I had to speak principally of the accessions made to our knowledge of that subject; but in recent years I have more than once made remarks before this Section on our ignorance of the same subject,—meaning by that, that there is much knowledge which we naturally wish for, and which is within our reach; but which we have not obtained and are not obtaining. The views which I have there given are further illustrated by the results of the tide observations made by the American Coast Survey under Superintendent Bache. One of the prominent points of our ignorance is, the nature of the movement of the water which produces the oceanic tides. When the progress of the tides on different coasts was represented by cotidal lines, it was found these lines made a very acute angle with the coasts which they met, and that the cotidal lines crossing the ocean were very convex. The great series of tide observations made on the coast of Europe and America in 1835 and 1836, made this feature, the acuteness of the angle made by the lines with the coast, stronger still. The results of Mr. Bache's observations make the cotidal lines on the coast of North America still more nearly parallel to the coasts. From this arises a great difficulty in drawing any cotidal lines across oceans, and indeed a doubt whether cotidal lines are proper modes of representing oceanic tides; though, doubtless, they are the best way of combining and representing our observations of littoral tides. The result is, that we are led to consider whether the oceanic tides may not be produced by a great oscillation of the ocean, the littoral tides being derived from them, and propagated by cotidal lines like waves along canals. [This view was proposed by Capt. FitzRoy as well as by Dr. Whewell several years ago.] In what manner the ocean really moves, to produce the tides, is not likely ever to be made out by tide observations made by separate parties ***aliud agendo***; but might probably be determined by means of an expedition (a single ship) sent out to ***hunt*** the tides;—to follow them from place to place, according to the order and manner suggested by the observations themselves, till their connexion is made out. Mr. Bache's survey has also produced other very curious and important results. It has shown the existence of the diurnal tide on the coast of California, in the Gulf of Mexico, and in other places; and it will lead to tide tables of the American ports, which will soon be published. Mr. Bache, after encountering some difficulties, has now obtained sufficient means of pursuing his survey, and is doing so with great energy and success.

METEOROLOGY.

On the Distribution of Rain in the Temperate Zones.

By Professor DOVE, *Berlin.*

The author, after giving a brief account of the manner in which rains are found normally to prevail in the Torrid Zone, and the causes which produced them, chiefly the ascending currents at the heated equatorial region, then proceeded to point out the numerous causes, general and local, which gave rise to a different and greatly diversified distribution of rain in the Temperate Zones, but showed that there were some localities in the middle of continents, as in Russia and America, where a very similar occurrence of causes, such as prevailed in the Torrid Zone, produced very similar results.—Col. Sykes mentioned several places in the Ghauts in India, where circumstances, similar to those noticed by Prof. Dove, could be observed. In that single locality, arising chiefly from differences of level, and of the manner in which the ascending currents of warm and damp air were guided by the character of the inequalities of the surfaces, every variation of fall of rain from 30 to 300 inches deep in the year could be found.—Capt. FitzRoy pointed out similar corroborations of Prof. Dove's views from his own observations in South America; and Prof. Phillips adduced several exemplifications from several localities in England.

Continuation of Remarks on the Climate of Southampton.

By JOHN DREW, *Ph.D., F.R.A.S.*

This communication was in continuation of a paper printed in full in the 'Report of the British Association for 1851;' and it likewise embraced general observations on subjects connected with practical meteorology. The tables, which have been published, contain the results of observations taken three times daily through the years 1848, 1849, 1850. These now presented continue the series by observations made once a day, viz. at 9 A.M., for 1851, 1852, 1853. The same care has been taken in observing, reducing, and recording, and the same instruments have been used throughout, except that for the last six months of 1853, the observations of Capt. Cameron, R.E., recorded at the Ordnance Map Office, Southampton, have been substituted, his own barometer having been out of order. The author having found that the mean temperature derived from the 9 A.M., 3 P.M., and 9 P.M. observations indiscriminately, agreed fairly, after the application of corrections for daily range with that deduced from

$\frac{\text{mean of max.} + \text{mean of min.}}{2}$,—a monthly correction used in the Greenwich observations—

has discontinued the two later daily observations for the last three years, as mean results were all that he aimed at; and after having tested his results by various comparisons, he feels fully persuaded that the mean state of the atmosphere, as regards pressure, temperature, and moisture, has now been determined for Southampton with such an approximate accuracy that for that end alone no further observations are required. The author then proceeds to comment on each of the five tables. Table I. contains the mean pressures for each month of the three years,—the maximum with the date of its occurrence, the minimum with the date of its occurrence, and the monthly range in separate columns. Table II. gives the mean temperature for each month from the 9 A.M. observations,—the mean of the maxima, the mean of the minima, the adopted mean (or calculated from both), the highest reading for the month and its date, the lowest for the month and its date, and the monthly range. The author calls attention to the very near accordance of the two methods of deducing the mean monthly temperature, and adds, that among other tests to which he subjected his observations, is a formula of Mr. Glaisher's, by which that element is supposed to be determined for any place in England, the mean temperature at Greenwich being known. This, for the five years from 1849 to 1853, is 49°·4. The formula is $49^\circ{\cdot}4 + (51^\circ{\cdot}5 - \text{latitude of place}) \times 0^\circ{\cdot}9 - 0{\cdot}00345 \times \text{height of place in feet above the level of the sea} = \text{mean temperature of the place}$. This, by substitution of the numbers peculiar to Southampton, becomes $49^\circ{\cdot}4 + (51^\circ{\cdot}5 - 50^\circ{\cdot}9) \times 0^\circ{\cdot}9 - 0{\cdot}00345 \times 60 = 48^\circ{\cdot}8$, a number nearly identical with the mean temperature of Southampton, deduced from the best observations. Table III. contains indications of the dry bulb, and of the wet bulb thermometers for each month of the three years, the difference, the deduced dew point, the degree of humidity, and the amount of cloud. The author remarks that the degree of humidity at Southampton appears to be consistently greater than that of Greenwich throughout the entire series of three years, as appears from the following comparison:—

	1851.	1852.	1853.
Greenwich	0·787	0·791	0·814
Southampton	0·823	0·834	0·849
Difference	+0·036	0·043	0·035

He also observes on the anomalies which exist in the degrees of humidity of Stone and York (both inland places), as given in the Registrar-General's Quarterly Report, which seems incomprehensible. Here is the comparison.—

	1851.	1852.	1853.	Mean for Three Years.
Greenwich	0·787	0·791	0·814	0·797
Southampton	0·823	0·834	0·849	0·835
Stone	0·839	0·821	0·868	0·843
York	0·805	0·844	0·888	0·846

Table IV. records the number of days of each month during which the wind blew from each of the eight principal points of the compass, and the mean force for each month. The author remarks that observers at several stations must either use very wrong estimates of the force of the wind, or their scale of comparison must differ altogether from that furnished by Dr. Lind's wind-gauge. The discrepancy is so great between several of those he found recorded in the Registrar-General's Report and his own, that he was nearly induced to reject his own *in toto* as worthless, till he became re-assured by finding great accordance between his own and those of Greenwich. He then shows that, according to the directions given by the Committee of Physics of the Royal Society, if we form an estimate for five places which he selects from the Report for the first quarter of 1852, violent storms must have blown the entire time at all these places. At Southampton, the average pressure of the wind is something less than 2 lb. on the square foot. Table V. is a continuation of Table VI., published in the Report for 1851. It contains a comparative view of the climates of Falmouth, the most southern town in England; Stone, near Aylesbury, an inland place about the middle of the southern portion of England; York, inland, and far to the north; and Southampton, near the coast, but more sheltered than Falmouth. Such comparisons as these the author considers most valuable. This valuable communication is also accompanied by an exemplar sheet for the month of March 1854, to show the manner in which the observations are made, reduced, and recorded. All the observed facts are recorded in black ink; all the reductions and deductions from the facts in blue.

Photogenic Drawings of Snow Crystals, as seen in January 1854. *By* JAMES GLAISHER, *F.R.S.*

This collection includes between 20 and 30 varieties, and was the result of a morning's observation on January 1st, 1854, with a temperature of 22°. The figures, though minute, and observed under a lens of very moderate power, exhibited a high degree of crystalline formation, and great harmony of arrangement. Temperature of air at 9 A.M. 23°. Difference of wet- and dry-bulb, 0°·5. Max. temp. during day, 31°·5. Min. temp. during day, 21°·2. Wind north. Photographic copies of the drawings made by Mr. Glaisher were presented to the meeting*.

Examination of the Storms which have visited England and Ireland during the years 1852, 1853, *and* 1854, *with reference to the Theory of Rotatory Storms. By* JOHN B. NEVINS, *M.D., Liverpool.*

Doubts having been started whether or not the rotatory character of storms followed them into high latitudes, the author was led to examine the leading records of storms in England and Ireland for these three years, to ascertain whether or not they partook of the characters of cyclones, viz. having a progressive motion from the west and south towards the east and north, at the same time that they had a revolving motion or whirl in the opposite direction to that of the hands of a watch in these latitudes. The observations examined by the author were those recorded in Armagh by Dr. Robinson, at the Liverpool Observatory by Mr. Hartnup, and at the Royal Exchange, London. Those made in Armagh register the velocity of the wind in miles for every hour, and the course to the nearest point of the compass. Those in Liverpool also register the velocity in miles for each hour, and the course to the nearest two points of the compass; whilst those made in London register the force of the wind in pounds upon a square foot, and the course of the wind to the nearest two points. Progressive motion of these storms was clearly marked (as shown in detail in a table) by the arrival of the leading phases of the same storms in succession, first at the most westwardly, and then more and more eastwardly: the intervals from Armagh to Liverpool varying from one to twelve hours. The commencement and the height of the storm invariably arrived first at Armagh, then at Liverpool, then at London, after distinct intervals. It in some instances, however, terminated in London before it had so terminated in Liverpool. The curved characters of the storms examined were also shown to be clearly marked in a second table. A third showed distinctly that the directions in which the wind was blowing at the same instant at each of these distant localities were different; and the difference the author showed in this third table was not unlike what should result from the revolving character of the general disturbance of the air. So far the theory of cyclones seemed to be borne out by facts.[*] But the author showed that, on observing the changes of the wind at any one of the stations during the progress of a storm, the recorded facts are at variance with any uniform progressive motion which can be conceived. He also showed, that from the commencement of the storm to its height occupied a much shorter time than from its height to its cessation; the latter interval being frequently more than twice the length of the former; and this he considered to be inconsistent with the supposition of their being cyclones. On the whole, the author concluded that in these high latitudes storms or masses of air do progress in a uniform order from west to east, and that the changes in the course of the wind during a storm indicate more or less of a curved direction; but that these changes are inconsistent with any uniform rotatory character; and that, judging from the observations of these three years, the law of cyclones does not obtain in the storms which visit the British Islands.

---

* Mr. Glaisher has since continued his observations, in the winter of 1854–55, and has published many drawings of extremely varied forms in the 'Illustrated London News.' Drawings of Arctic snow crystals may be consulted in Scoresby's 'Voyages.'

TABLE 1.

1852.	Commencement.	Height.	Termination.
Jan. 3, 4.			
Armagh	2 A.M. Jan. 3	11, 12 A.M. Jan. 3......	10 A.M. Jan. 4.
Liverpool	10 A.M. Jan. 3	9, 10 P.M. Jan. 3, and again 5–9 A.M. Jan. 4.	9 P.M. Jan. 4.
London	3–9 A.M. Jan. 3.........	10 A.M. to 2 P.M. Jan. 3, and again 10 P.M. to 2 A.M. Jan. 4.	5 A.M. Jan. 4.
Jan. 8, 9, 10.			
Armagh	3 A.M. Jan. 8	1, 2 P.M. Jan. 8	5, 6, 7, 8 P.M. Jan. 9.
Liverpool	4 A.M. Jan. 8	3–7 A.M. Jan. 9	8 A.M. Jan. 10.
London	8–11 A.M. Jan. 8	12 P.M. Jan. 8, and 2 A.M. Jan. 9.	— A.M. Jan. 10.
Feb. 15, 16, 17, 18			
Armagh	Wind high all the 15th, but nearly uniform; began to increase steadily at 11 P.M. Feb. 15.	7–9 P.M. Feb. 16	Falling 10 P.M. Feb. 17, and then nearly uniform till 2 P.M. Feb. 18—over.
Liverpool	10 A.M. Feb. 16.........	7–10 P.M. Feb. 16, and continuing with little abatement till noon Feb. 18.	4 A.M. Feb. 19.
London	11 A.M. Feb. 16.........	11 P.M. Feb. 16	Not recorded.
Dec. 24, 25.	Could scarcely be called a storm.		
Armagh	11 P.M. Dec. 24	3, 4 A.M. Dec. 25	11 A.M. Dec. 25.
Liverpool	12 P.M. Dec. 24	5, 6 A.M. Dec. 25	3–5 P.M. Dec. 25.
London	Wind all afternoon of 24th.	3–6 A.M. Dec. 25	1 P.M. Dec. 25.
Dec. 26, 27.			
Armagh	Wind all day Dec. 26...	5–7 A.M. Dec. 27	6–8 P.M. Dec. 27.
Liverpool	10 P.M. Dec. 26.........	9–11 A.M. Dec. 27......	9 P.M. Dec. 27.
London	Not recorded	10 A.M. Dec. 27.........	7 P.M. Dec. 27.
1853.			
Feb. 25, 26.			
Armagh	6 P.M. Feb. 25	5, 6 A.M. Feb. 26	6 P.M. Feb. 26.
Liverpool	9 P.M. Feb. 25	12 Noon to 2 P.M. Feb. 26.	7 A.M. Feb. 27.
London	2 A.M. Feb. 26	11 A.M. to 2 P.M. Feb. 26.	Record terminating suddenly at 3 P.M. Feb. 26.
Mar. 31, Apr. 1, 2.			
Armagh	1 A.M. Mar 31	11, 12 P.M. Mar. 31 ...	Wind high, but nearly uniform, for many hours, from 8 P.M. Apr. 1 to 6 P.M. Apr. 2, when it was over.

Table I. (*continued.*)

1853.	Commencement.	Height.	Termination.
Mar.31, Apr.1,2			
Liverpool	8 A.M. to 4 P.M. Mar. 31	9 A.M. to Noon Apr. 1.	10 P.M. Apr. 2.
London	Not recorded	1 A.M. Apr. 1	— A.M. Apr. 2.
Sept. 25, 26.			
Armagh	Several hours P.M. Sept. 24.	3, 4 A.M. or 11, 12 A.M. Sept. 25.	9 P.M. Sept. 25.
Liverpool	9 A.M. Sept. 25	5–11 P.M. Sept. 25	7–11 P.M. Sept. 26.
London	8 A.M. Sept. 25	12 P.M. Sept. 25	Not recorded.
1854.—Jan. 26.			
Armagh	— P.M. Jan. 25	5 A.M. Jan. 26	3 P.M. Jan. 26.
Liverpool	5 A.M. Jan. 26	10, 11 A.M. Jan. 26	6 P.M. Jan. 26.
London	No wind affecting the pressure instrument.		
Feb. 17, 18, 19.			
Armagh	— P.M. Feb. 16	7–9 A.M. Feb. 17	5 A.M. to 3 P.M. Feb. 18.
Liverpool	1 A.M. Feb. 17	7 P.M. Feb. 17 to 4 A.M. Feb. 18.	5 A.M. Feb. 19.
London	1 A.M. Feb. 17	6–10 P.M. Feb. 17	Not recorded, but abating A.M. Feb. 18.

Table II.—Changes in the Direction of the Wind.

1852.—January 3, 4.

Armagh ...... sw by w; ssw; s by w; ssw; sw by w; wsw; w by s; wsw; sw by w; wsw; sw; wnw; nw.
Liverpool ... ssw; s; ssw; sw; wsw; wnw; w; wnw; nw.
London ...... sw; wsw; sw; ssw; sw; ssw; wsw; wnw; w.

January 8, 9, 10.

Armagh ...... ssw; s; s by w; ssw; s by w; ssw; sw by s; wsw; nw by w; nw; then for many hours from nw to wnw, w by n, and n by w.
Liverpool ... s; sse; se; sse; s; ssw; s; w; wnw; nnw; nw; wnw; nw; nnw.
London ...... s; ssw; sw; wsw; wsw; s; ssw; wsw.

February 15, 16, 17, 18.

Armagh ...... w; w by s; w; wsw; w by s; w; w by n; w; w by s; sw by w; w by s; w; w by n; w; w by s; w; w by s; wnw; nw by w; n by w; nw.
Liverpool ... w; wnw; w; wnw; w; wnw; w; wnw; nw; wnw; w; wnw; w; wnw; nw; nnw; n.
London ...... sw; ssw.

December 24, 25.

Armagh ...... sse; se by s; sse; sw by s; wsw; nnw; wsw; sw by w; sw.
Liverpool ... sse; s; ssw; sw; wsw; w; wsw; w; wsw.
London ...... ssw; wsw; w; wsw.

December 26, 27.

Armagh ...... sse; s; s by w; s; s by e; s; s by w; ssw; sw; w by s; sw by w.
Liverpool ... sse; s; sw; ssw; sw; wsw.
London ...... Commencement not recorded; ssw.

1853.—February 25, 26.

Armagh ...... sw; w by n; w; w by s; w; w by n; wnw; w by n; wnw; nw; nnw; nw by w.
Liverpool ... w; wsw; sw; wsw; w; wnw; nw; nnw; w.
London ...... wnw; ssw; sw; wsw; ssw; wsw; w.

March 31; April 1.

Armagh ...... se; se by s; sse; se by s; se by e; sse; se by s; se by e; se; ese; e; e by s; e; e by s; then there was almost a calm for three hours, and the wind began at sw by w, w by s, wsw, w by s, and wsw, till the storm was over.
Liverpool ... sse; se; sse; s; ssw; sw; wsw; w.
London ...... Commencement not recorded; sse; s; ssw; sw; wsw.

TABLE II. (*continued.*)

September 25, 26.

Armagh ...... s by e; s; s by w; ssw; sw by w; wsw; sw by w; w by s; nw.
Liverpool ... sse; w; wnw; nw; nnw; nw; nnw; nw; nnw; nw; wnw; nw; wnw.
London ...... sse; s; ssw; sw; wsw; w; wsw. Conclusion not recorded.

1854.—January 26.

Armagh ...... wsw; sw by w; sw; wsw; sw by w; w by s; w; w by n; wnw; w.
Liverpool ... sw; ssw; w; wnw.
London ...... ssw; sw; wsw; sw; wsw; wnw; w; wsw; sw; s.

February 17, 18, 19.

Armagh ...... wnw; w by n; w by s; wsw; w by n; wnw; nw by w; nw; nw by n; nnw.
Liverpool ... w; wsw; w; wnw; nw; wnw; nw; wnw; nnw; n.
London ...... sw; wsw; w; wnw.

TABLE III.—Diversity of Wind at same hours in the Three Stations for the December Storms, 1852.

1852. Dec. 24.	P.M.		Dec. 25.—A.M.							
	11	12	1	2	3	4	5	6	7	8
Armagh	SSE	SE by S	SSE	SW by S	...	WSW	NNW	WSW	SW by W	...
Liverpool ...	SSE	...	...	S	SSW	SW	WSW	...	W	...
London	SSW	...	...	...	...	...	...	...	WSW	...

	A.M.				P.M.				
	9	10	11	12	1	2	3	4	5
Armagh	...	...	SW	...	...	...	SW by S	...	...
Liverpool ...	...	...	WSW	...	W	...	WSW	...	...
London	W	WSW	...	...	...	...	...	SW	SSW

1852. Dec. 26.	P.M.			Dec. 27.—A.M.								
	10	11	12	1	2	3	4	5	6	7	8	9
Armagh ...	SSE	S	S by W	S	...	S by E	S	S by W	SSW	SW	...	W by S
Liverpool .	SSE	...	S	...	...	...	...	SW	SSW	SW	...	...
London ...				Not recorded.								SSW

	A.M.			P.M.							
	10	11	12	1	2	3	4	5	6	7	8
Armagh	...	...	...	...	...	...	SW by W	...	...	SW	...
Liverpool ...	...	...	WSW	...	...	...	...	...	...	...	...
London	...	...	...	...	...	...	...	...	...	...	...

TABLE IV.—Amount of Wind preceding and following the Height of Storms.

		Before.	After.
1852.	January 3	632 Miles	391
—	January 8	640 ,,	969
—	February 15	976 ,,	1936
—	December 24	156 ,,	313
—	December 26	430 ,,	406
1853.	February 25	420 ,,	532
—	March 31	473 ,,	959
—	September 25	284 ,,	780
1854.	January 26	61 ,,	144
—	February 17	725 ,,	951
		4794	7381

Mr. F. **Osler** gave a description, with drawings, of his Anemometer and Rain-Gauge at the Liverpool Observatory, combining successive and important improvements upon his original instrument, which he introduced in Liverpool at the meeting of the British Association in 1837, with a Report of the recorded observations.

On the Meteorology of Huggate, Yorkshire Wolds.
By the Rev. T. RANKIN, *M.A.*

The author has for many successive years annually furnished to the Association detailed reports of meteorological observations recorded by himself. The present gave the tabulated results; the observations being taken at 9 A.M. and 2 P.M., in a northern shaded aspect. The tables were—1, of the thermometer, showing, for the year, monthly means of the maximum, minimum, difference, lowest range and greatest range;—2, of the barometer;—3, winds;—4, character of weather;—5, rain;—6, hygrometer. These were accompanied by observations, drawing attention to the days and amount of the most remarkable phænomena under each head: also, notes of the Great November Wave of Auroræ Boreales and thunder-storms; and such a comparison with the recorded observations at other less elevated stations as led the author to the conclusion,—"That the range of the thermometer decreases as the elevation of the locality above the level of the sea increases."

The Meteorology of Nice Maritime for 1853. *By* Col. SYKES, *F.R.S.*

Nice is situated in latitude 43° 41′·17 N. and longitude 4° 56′·22 E. of Paris. The meteorological observations were taken by Mon. Teyssiere, a French gentleman, in the Maison Tiranty, with a northern aspect, at an elevation of 59·06 feet above the ground, and 75·46 feet above the sea level. Mon. Teyssiere had his instruments compared with a standard set introduced into the 'Ecole de Commerce' in 1853.

Temperature.—The coldest month in 1853-54 at sunrise was February, 38°·93, then December, 41°·13, and then March. In January the temperature did not fall once to the freezing point, and in February only twice. The mean temperature of February was 42°·55, of December 44° 85, and of March 46°·74. On the 19th and 20th snow fell to the depth of a foot, and on the 7th, 8th, and 13th snow fell on the neighbouring hills, while none fell in Nice. The hottest month was August 75°·56, and July 72°·61, but the maximum height of the thermometer was 90°·86 on the 3rd September.

Range of temperature.—The range of the thermometer, annual, monthly, or daily, was never great. The mean minimum daily range was in December 8°·36, and the maximum in August 12°·70. The maximum range in any one day was on the 8th September 16°·2. The greatest daily range in the cold months was 15°·48. The mean range in the year was 40°·63, and the absolute range was from 28°·60 on the 29th December, to 90°·86 on the 3rd September=62°·26, but this was an exceptional case.

Pressure of the atmosphere.—Like the temperature, there is considerable equability in the movement of the barometer, partaking, in fact, of a tropical character. The maximum pressure was 30°·393 for nearly three days, 26th, 27th, and 28th of January 1854; but the highest in 1853 was 30°·197 on the 1st January 1853. The lowest indication of the barometer was at 2 P.M. and sunset on the 9th February 29°·015, and the same on the 19th February, the extreme range of pressure therefore was 1·378 in. The extreme range for ten years, 1833 to 1842, at Genoa was only 1·904 in. The extreme monthly range was in January 1·102 in.

Range of pressure.—The daily range was very limited, rarely exceeding 0·157, and in a thunder-storm it never amounted to 0·393. In the summer months the barometer scarcely moves for days together. The mean pressure for the year at Nice was 29°·601, and for ten years at Genoa 29·788 in.

Annual curve.—The annual curve of pressure shows, as in India, a relation to the position of the sun in the ecliptic; being greatest when the sun is farthest south, and gradually diminishes as the sun comes north. Ten years' observations at Genoa show this feature in a marked manner annually.

Daily tides.—At Nice also, although the hours of observation were unfavourable, the daily oscillations, with two maxima and two minima, for convenience called atmospheric tides, were discoverable. The Genoa records show the same in every month.

Rain.—Measurements of rainfall were not made by Mons. Teyssiere in 1853, but Mr. Wilkins in his book says the fall in winter is 3 to 7 in., spring 3 to 8 in., summer 2 to 7 in., and autumn 6 to 18 in., and the mean fall for the year 24 in.; a maximum in any one year 41 in., and a minimum 15 in. In 1853, in 1486 observations, rain fell 166 times, the maxima being 32 times in May and 27 times in October; the sky was clear 930 times, overcast 309 times only, haze 14, fogs 3, stormy 13; thunder, hail, or snow 26 times.

Winds.—The most remarkable feature is the paucity of the winds from southerly quarters. In 1390 observations it blew from the south only 31 times, S.E. 57, S.W. 169, N. 291, N.E. 139, N.W. 168, so that northerly points give 598 winds, and southerly only 257. The east wind blew 124 times, and the west only 66 times.

Electricity.—Observations were not made for electricity.

The above analysis shows that the meteorology of Nice and Genoa, and by inference that of the Maritime Alps, presents some features common to a tropical climate;—comparatively equable pressure, and limited range of atmospheric pressure, moderate temperature, and small range of the thermometer whether daily, monthly, or annual; no excess of heat in the summer, no great depression of temperature in the winter, an unclouded sky for weeks together; violent winds and tempests rare, serenity of the atmosphere being a characteristic, and added to all this, perennial verdure: there would thus appear to be a combination of physical circumstances highly conducive in the people to freedom from formidable diseases, and more especially those affecting the respiratory organs; nevertheless the official medical returns show that the deaths from the diseases of these organs far exceed the deaths from any other cause, not less at Nice than at Geneva and Turin, and exceed the proportion from similar diseases of the respiratory organs in London.

On the Meteorology of the Albion Mines, Nova Scotia. *By* H. Poole.

The Albion Mines are situated in the county of Pictou and province of Nova Scotia in North America, lat. 45° 34′ 30″ north, and long. 62° 42′ west from Greenwich. They are upon the western side of the East river, which flows in a northerly direction from its source in the St. Mary's mountains until it empties itself into the bay or harbour of Pictou, which is one of the most eastern harbours of the continent of North America, and opening into the Gulf of St. Lawrence.

The sea is distant about ten miles, with some rising land intervening, but probably not more than 250 feet high. The ground rises moderately on all sides around the mines, except in the direction of the river, which at this point spreads into two branches, and forms an interval of rich soil of about half a mile in breadth. The surface of the surrounding country is very undulating, being intersected by brooks or small streams (often dry in summer) running in every direction.

The soil in the immediate vicinity of the mines is of a loamy clay, forming a thin crust upon the aluminous shales lying below, and which dip in a north-easterly direction at a general angle of 19°; several thick seams of coal lie below and alternating with the shales; while the limestone formation underlying the coal measures crops about one mile to the south-west of the mines, and gives its characteristical formation of conical hills to the surface of the country. Pines and spruce have been the prevailing forest trees upon the uplands, with birch and maples intermixed on some parts; while large hemlocks have marked the lines of the brooks, and a few elms have grown upon the interval between the forks of the river; and as hardly any of the clearances extend one mile back from the banks of the river, the country may be considered as almost in its primeval forest state as regards the climate of the country.

The latitude being 45° 34′ 30″ north, we enjoy the sun's influence in the shortest days for eight hours and forty minutes, and in the longest days during fifteen hours and twenty minutes.

The mean temperature of the earth at this latitude is theoretically calculated at 58° *, but from the mean daily observations for ten years taken twice a-day, or the two extremes of night by a self-registering thermometer, and by actual observation at noon, it is found to be 41°·94 at the mines, or 16° colder than theoretically estimated, owing chiefly to its position on the east side of the continent, and to the cooling influence of the sea breezes during the summer months.

The mean temperature of the year is found to vary in different years to the extent of 3½°, but the observations have not been extended through a sufficient number of years to know whether the fluctuations are periodical or not.

159° have been observed under the full influence of the sun's rays, and 40° below zero were observed at the bottom of the coal pit (250 feet deep) when the thermometer on the surface registered 22°.

The greatest heat that has been observed in the shade 6 feet above the ground was 98°, and the greatest cold 22° below zero, giving an extreme range of 120°.

By dividing the year into two parts at the mean temperature of 42°, there are 190 days of warm and 175 days of cold weather; the mean temperature crossing that line on an average of ten years on the 1st day of May and 6th day of November.

If we divide the year into four seasons, and assume winter to continue whilst the daily mean is below 32°, spring and autumn to last while the daily mean is 10° below and above the annual mean, or from 32° to 52°, and call it summer whilst the daily mean is above 52°, we shall then have the average length of the seasons as follows:—

Spring 32° to 52° from 27th March to 31st May........	66 days.
Summer all above 52° from 1st June to 24th Sept.	116 ,,
Autumn 32° to 52° from 25th Sept. to 26th Nov.	63 ,,
Winter all below 32° from 27th Nov. to 26th March...	120 ,,
	365

The mean temperature has varied during ten years only 3½° of Fahr., a quantity certainly very inconsiderable when we compare by sensation the warmth of one hour of the day with another, yet capable, when added or subtracted from the whole year, of producing a decided difference in the seasons. We must not, however, too hastily connect with a low mean the idea of a cold winter, or that of a hot summer with a high one. The heat is added or taken away sometimes in one season or quarter of a year, sometimes in another; and again occasionally almost throughout the year, as will be more distinctly seen by an examination of the table of mean temperature†; or it may be caused by the difference between the mean temperatures of day and night, which I consider an important deviation, and deserving of further inquiry, as it affects vegetation.

The registry of the weather at these mines was originally commenced at the request of Admiral Owen, and accordingly published in the Pictou papers, so that he might compare our weather, and more particularly the course of the wind, with the register kept by the surveying party on board H.M. steamer 'Columbia' in the Bay of Fundy; it was afterwards forwarded to the Smithsonian Institute at Washington to be incorporated along with the numerous registers kept in other parts of the continent of North America; and having now been kept for a decade of years, it is hoped that the following tables and summary of some facts deduced therefrom may be of interest to the friends of meteorology.

It is proper here to acknowledge that Howard's 'Climate of London' has suggested the plan of the greatest part of the work; and a desire to compare the climatic phænomena on the east side of North America with those recorded by him on the opposite side of the Atlantic or on the west coast of Europe, has been the chief inducement for doing so.

It is to be regretted that the instruments used have not been compared with standard ones; and therefore no corrections have been attempted to be made excepting the correction of the barometrical readings for temperature by the tables of the Royal Society of London. This barometer, with thermometer attached, is

---

* By Brewster's formula, 81·5 Cos Lat.

† These Tables are not published in the present Report.

hung in a sitting-room at 120 feet above the level of the sea; it is graduated from a fixed point, and the mercury is enclosed in a kid cup.

Two thermometers, self-registering for night, are hung 6 feet from the ground on the side of the house exposed to a N.E. direction, but protected from the N.W. winds by a clump of trees at a few yards distance; another registering thermometer is placed upon the ground and exposed to the full action of the atmosphere, and the difference in its readings at night from the other thermometers placed on the house was shown in a Table.

The rain is measured by a 12-inch diameter funnel-shaped tin pipe, where 1 inch of the funnel reads as 9 inches of the float-rod; the snow is received into a pail of 3 feet depth and 8 inches in diameter, suspended by a double ring like a ship's compass, so that no snow-drift falls into it, and the melted snow is measured in the rain-gauge.

The force of the wind has been measured during 1852, to a certain extent, by a machine having a board of 1 foot (made to face the direct action of the wind) pressing against a spring which marked the force in pounds of pressure. The clearness of the sky, velocity of clouds, and also the direction of the different currents, are from observations made with the naked eye at different times in the day. Other atmospheric phænomena have been recorded where it was thought that they might assist in elucidating changes or modifications in the climate.

Our winter begins by the temperature on the 27th November, and continues 120 days, or nearly one-third of the whole year. The mean temperature of the season is 20°·857 for the months of December, January, and February, but for the whole 120 days the mean temperature is 22°·015. The hottest day during the ten years was the 11th January 1843, when the thermometer did not fall below 42° at night and rose to 63° in the day, or a mean of 52°·5. The coldest day was the 19th January 1849, when the thermometer at night marked —15° and did not rise above —8° all day, or a mean of —11°·5; greatest cold —22° on 7th January 1851.

The mean height of the barometer is 29·6903 ins., being ·0497 in. below that of autumn. The range of the column is greatest in this season; the highest, 30·757 ins., being on 28th February 1849, and the lowest, 28·410 ins., on 31st December 1848. The mean range is 2·125 ins.

The winds prevail from south to west and west to north during December, while northerly winds prevail in January and February. Upon the mornings of greatest cold, or when below zero, the wind generally blows from the S.S.W. The average rain, including melted snow, is 11·5282 ins., of which nearly 5 ins. fall in December. It only hailed four times during the ten recorded winters, whilst there is scarcely a January passes but there is lightning or thunder once.

When the frost sets in it generally continues steady for a length of time. The longest frost without a break was from 3rd December 1848 to 22nd March 1849, or 108 nights; with the exception of a rain storm on the 12th February, there was frost from 24th November 1851 until the 21st April 1852, or 142 days. The shortest frost was only 32 days in succession in the winter of 1844–45. During the continuance of these frosts the ground is generally covered with snow, so that the vegetation and roots of the grasses do not suffer, and good roads are made upon it which enable the farmer and lumberer to carry their produce easily to market. Fogs are rarely seen; the atmosphere is generally dry and bracing, and there are but few days on which workmen are unable to work out of doors; people expect it to be cold, and are accordingly clad in woollens; and it is remarked that the more steady and colder the winter is, the more healthy are the inhabitants.

Occasionally a silver thaw will encase the trees, &c., sometimes nearly to the thickness of an inch, and then the fruit trees are apt to have their branches broken by the weight; but it is a magnificent sight to see the forest or even a single tree bending in graceful curves beneath its crystal load, and reflecting the rays of the sun from every point with all the prismatic hues of the rainbow. The sun was not visible from the 15th to the 31st December 1843.

Spring commences on the 27th March according to the temperature; its duration is only sixty-six days, during which the medium temperature is elevated from 32° to 52°. The mean of the normal season is 37°·44, but for the sixty-six days it is 43°·12; the sun effecting by his approach an advance of 11°·105 upon the mean temperature of the winter. The temperature increases very regularly about 10° each month from February to June, contrary to the sudden starts to which it is subject in Britain. The easterly winds prevail in April and May, which keeps the weather cold, and sometimes a foot of snow falls; but in general there are fewer days of rain, and less falls in April than in any other month.

One half of the nights are frosty; the mean temperature at *night* in April being 27°·637, while May is as low as 37°·63; this greatly retards vegetation, although the sun has great power; the average heat in the daytime in April being 46°·24, and in May 59°·287. In 1844, on the 1st April, the thermometer marked 3° below, and on the 2nd 2° below zero; this very unusual degree of cold was followed by a fortnight of calm fine weather with northerly winds, and very little snow or rain falling.

The mean height of the barometer for the normal spring is 29·7067 ins., being ·0164 inch above the winter. The extreme elevations and depressions of the column go off in great measure during the season, and by the end of spring the range is contracted to about 1⅓ inch. Mean range of the season 1·665 inch.

The wind is easterly for one-third of the time, which is in a great measure owing to the large bodies of floating ice off in the Gulf of St. Lawrence; so that although the westerly winds blow generally during the nights and early in the mornings, yet it is almost sure to shift round towards the N.E. as soon as the sun raises the temperature, or about ten o'clock in the morning.

The average rain is 9·9439 ins.; the showers are generally heavy and not of long continuance, while the evaporation is excessive; so that in a few hours afterwards the land is in good order for the farmer to proceed in sowing his crops.

Summer begins on the 1st of June and lasts for 116 days according to the temperature, with a mean temperature of 6°·187, the whole 117 days being above 52°; the sun effecting by his position in the northern hemisphere an advance of 18°·75 upon the mean temperature of the spring. The temperature of the normal summer is 63°·36. The medium of the twenty-four hours rises during the season from 52° to 73°·5, and returns again by the close to the former level on the 24th September. The mean temperature of July and August do not differ from each other more than the tenth of a degree, while for four years out of the ten there was a slight frost on one morning in the month of July as well as August, while upon an average there are four frosty nights in June and five in September, so that frequently there is frost in every month of the year.

The mean height of the barometer for the normal summer is 29·7180 ins., or ·0113 inch above the vernal mean.

The mean range is 1·07 in. In England the least range is in the month of July, while here it exceeds the mean range of both June and August by nearly one-tenth of an inch; the least range being 1·063 in. in June. The predominating winds in this season are from south to west; but still one-third of the time the wind blows during the day from north to east or from east to south; but this cannot be more than a local breeze, for the upper currents, as shown by the course of the clouds, mark in general a S.W. current.

The mean rain is 9·6048 ins., less falling in June than in any other month of the year.

Autumn begins on the 25th of September, and lasts only sixty-three days, or until the mean temperature falls again below 32°. The mean temperature of the season is 46°·243, being 17°·12 below the three months of summer, but the mean temperature of the sixty-three days is 43°·04.

The mean height of the barometer for the normal autumn is 29·740 ins., being the highest average throughout the year, and the extreme range 2·102 ins.

The winds blow for two-thirds of this season from south to west and west to north.

The average quantity of rain is 13·5264 ins., October being our wettest month as regards quantity; but as the showers are heavy and not of long continuance, there is a good deal of fine pleasant weather at this season of the year, particularly about the end of October or beginning of November, when there are ten days or a fortnight of clear sunny days with the temperature rather above the mean, and which short period is usually called the Indian summer.

The dews are frequently very heavy at this season, so much so that the quantity precipitated in one night in the rain-gauge has often measured the one or two thousandth part of an inch.

The mean height of the barometer, as deduced from the observations taken during a period of ten years, is 29·71377 ins. at an altitude of 120 feet above the level of the sea.

In a general Table* were exhibited the greatest and least elevations of the barometer in each month for the ten years 1843 to 1852. To the maximum heights of each year was annexed the mark × and to the minimum 0. Of the yearly maxima, the greatest number, or one-half, occur in the first two months, and the rest at the end of the year, with one exception in April. Six of the yearly minima occur in the last two months of the year; the other four minima occur in the beginning of the year. Thus there are five months (May to September) in which the barometer visits neither extreme of its yearly variation, while the higher and lower annual extremes are chiefly the product of what constitutes the winter at this station.

Another Table*, drawn from the results of the preceding one, serves for more easy reference. The average of the third column, or the medium between the average elevations and depressions, is seven hundredths of an inch below the mean height for the climate (29·71377 ins.), the reason of which is that the depressions occupy a smaller space of time than the elevations; in consequence, a less proportion of them comes into an average founded on daily results.

The average annual range is 1·944 in.; the range varies in different years about six-tenths of an inch.

The greatest elevation in ten years appears to have been 30·757 ins. "corrrected" on the 27th February 1849; the day was introduced by a moderate N.N.E. breeze, a rimy frost and fog in the morning; the temperature was 1° below zero during the preceding night, it stood at 35° at noon; the day was very fine, with a few cirrus clouds from the west. The next highest was 30·753 ins. "corrected" on the 2nd April 1844, when the wind had also prevailed for three days from the N.E., but was gentle from the south at the time of the extreme range. The temperature had been unusually low, 3° below zero on the night preceding the 1st, and 2° below zero on the 2nd; the temperature was only 23° at noon on the 1st, and 32° at noon on the 2nd. Fog at sunrise on the 1st; cirrus clouds from S.W. on both days, and on the 2nd halo round both the sun and moon.

The greatest depression in ten years occurred on 3rd November 1851, when the barometer descended to 28·505 ins. at 12 P.M.; there was fog in the evening, with lightning and thunder at 10 P.M.; the wind was a fresh breeze from the S.W.; the temperature was 54° out of doors at 9 P.M. Howard's observation in England, that neither extreme is produced very suddenly, is not borne out here; it has often been known to rise or fall about an inch within twenty-four hours, and the two extremes have occurred within a few days of each other; while in February and March 1849 the barometer never fell below 30 ins. for seventeen days in succession.

Rain.—The mean annual depth of rain is 44·9676 ins. for ten years; the greatest quantity, 58·805 ins., being in 1848, and the least quantity, 32·921 ins., being in the year following, or 1849.

Contrary to the observed connexion in England between a wet and cold season, and a warm and dry one, no such affinity appears to connect them at this station; for the greatest quantity of rain fell in 1848, when the mean temperature was 43°·2, or 1°·3 above the mean†, while the driest year was 1849, when the mean temperature was 41°·1, or ·8 below the mean.

The greatest quantity that fell in any one month was 10·58 ins. in October 1843, and the least quantity ·913 in. in May 1849.

Upon an average the greatest quantity falls in the month of October, confirming the correctness of the observations of the Indians, who say that the frost never sets in until the brooks are full. The least quantity of rain falls in the month of June.

Upon an average it rains on 171 days in each year, and twice as often in the daytime as during the night.

---

[*] These Tables are not published in the present Report.

[†] Seven inches above the average falling in the first quarter, when the mean temperature was 4° above the average.

In August 1848 it rained 6·328 ins. in four days, and 1850, September 8th, it rained 3·955 ins. in twenty-four hours; the storm in both instances blowing from N.W. to N. and N.E.

With regard to the proportions of rain in the former and latter half of the year, they stood thus by the average:—

For the first six months, January to June, 18·7465 ins.; for the latter six months, July to December, 25·8568 ins. The sums of the mean temperature of these two portions thus divided are 208·97 ins. and 294·70, being nearly one-third higher in the latter half of the year.

If we divide the circle in another place we shall have a very different result.

From the fourth to the ninth month (April to September) the average rain amounts to 18·1572 ins., from the tenth to the third month (October to March) 26·4461 ins. Now the sum of the mean temperatures of the first six months in this series, or the summer half-year, is 331·51, and that of the remaining six months, or winter half-year, 172·16. Here the relative quantities of rain remain about the same, while the temperatures are reversed.

In Howard's 'Climate of London,' the driest month in the year is March 1, February 2, April 3, May 4, June 5, September 6, January 7, August 8, December 9, October 10, July 11, November 12; while at the Albion Mines June is 1, April 2, May 3, September 4, July 5, February 6, January 7, March 8, August 9, November 10, December 11, October 12.

January.—The sun in the middle of this month continues about 9 hours and 6 minutes above the horizon. The temperature rises in the day, on an average of ten years, to 25°·46, and falls in the night to 12°·18; the difference, 13°·28, representing the mean effect of the sun's rays for the month, may be termed the solar variation of the temperature.

The mean temperature of the month is 18°·84; but this mean has a range of 13°·1 in ten years, which may be termed the lunar variation of the temperature. The warmest year was 1843, when the winds prevailed from the S.W.; and the coldest was 1851, when the winds prevailed from the N.W. and N.E.

The barometer in this month rises on an average of ten years to 30·3515 ins., and falls to 28·9012 ins.; the mean range is therefore 1·4503 in.; but the extreme range in ten years is 2·012 ins. The mean height for the month is 29·6958 ins.

The prevailing winds are the class from west to north; the average of ten years being north to east 3·8, east to south 4·4, south to west 7·4, west to north 15·4.

The mean rain or melted snow at 3 feet from the earth is 3·3814 ins.; and the number of days upon which it falls averages 5 nights and 11 days, or a total of 16.

The snow falls upon an average of 13 days, and a mean depth of 1ft. 10 ins. The heaviest storm was in 1844, when it snowed 2 ft. 9 ins. on a level in three days In the first part of the winter the snow is very dry, and it takes 17 ins. of snow melted to make 1 in. of water.

Upon an average, 29 nights have constantly the temperature below the freezing-points, while 6·7 nights and 1 day fall below the zero-point. The mean degrees of frost average 623; the greatest number, 825, being in 1851, and the least, 447, in 1843.

February.—Length of day in the middle of the month about 10 hours 18 minutes. Mean of greatest heat by day 28°·075, of greatest cold by night 10°·95; difference, or solar variation, 17°·125.

Mean temperature of the month 19°·51; difference in the mean or lunar variation 13°·3. The warmest years were 1848 and 1850, when the winds prevailed from the N.W.; and the coldest year was 1849, when the wind prevailed from the north to east.

The barometer ranges on a mean from 30·365 ins. to 28·905 ins.—difference 1·460 ins.; but the full range in ten years extends to 2·174 ins. Mean height for the month is 29·6866 ins.

The prevailing winds are the class from west to north; the average of ten years being north to east 4·2, east to south 4·9, south to west 6·9, west to north 12·3.

The mean rain or melted snow is 3·2673 ins., falling on an average on 4 nights and 9 days, or a total of 13 through the month.

The snow falls on 11 days upon an average, and a mean depth of 2 ft. 1 in. The heaviest storm was in 1849, when it snowed 2 ft. 6 ins. in two days.

There are 27 nights of frost upon an average, while 7·7 nights go below zero; and in three years there was one day on which the temperature kept below zero all day. The mean degrees of frost average 600; the greatest number, 870, in 1849, and the least, 433, being in 1850.

March.—Length of day in this month averages 11 hours 42 minutes. Mean of greatest heat by day 36°·135, of greatest cold by night 17°·85; difference, or solar variation, 18°·285.

Mean temperature of the month 26°·98; difference in the mean or lunar variation 8°·7. The warmest year was 1846, and the coldest year was 1847, when the winds prevailed from the west to north.

The barometer ranges on a mean from 30·282 ins. to 28·916 ins.—difference 1·366 ins.; but the full range in ten years extends to 1·776 in. Mean height for the month is 29·672 ins.

The prevailing winds are the class from west to north; the average of ten years being north to east 5·5, east to south 5·5, south to west 7, west to north 13·0.

The mean rain or melted snow is 4·3963 ins., falling on an average on 4 nights and 10 days, or a total of 14 through the month.

The snow falls on 11 days upon an average, and a mean depth of 2 ft. 1¾ in. The heaviest storm was in 1850, when it snowed 16 ins. in three days. There are 28 nights of frost upon an average, while 2·8 nights go below zero. The mean degrees of frost average 453; the greatest number, 557, in 1849, and the least, 338, being in 1846.

April.—Length of day in the middle of the month 13 hours 22 minutes. Mean of greatest heat by day 46°·24, of greatest cold by night 27°·63; difference, or solar variation, 18°·61.

Mean temperature of the month 36°·88; difference in the mean or lunar variation 5°·6. The warmest year was 1843, and the coldest 1850; in the former the wind prevailed from the south to west, and in the latter from north to east.

The barometer ranges on a mean from 30·2763 to 29·0248 ins.—difference 1·2515; but the full range extends to 1·871 in ten years. Mean height for the month is 29·7022 ins.

The prevailing winds are the class from west to north; the average of ten years being north to east 7·7, east to south 3·5, south to west 7·4, west to north 11·4.

The mean rain or melted snow is 2·650 ins., falling on an average on 4 nights and 8 days, or a total of 12 days through the month.

The snow falls on 7 days upon an average, and a mean depth of 9½ ins. The heaviest storm was in 1852, when it snowed 12½ ins. in two days.

There are 24 nights' frost upon an average, and in 1844 two nights went below zero. The mean degrees of frost are 165; the greatest number, 257, in 1850, and the least, 92, being in 1846.

May.—The length of the middle day is about 14 hours 38 minutes. The temperature rises by day to 59°·28, and falls by night to 37°·63; the solar variation is consequently 21·65.

Mean temperature of the month 48°·44—difference in the mean or lunar variation 9°·4. The warmest year was 1846, when the winds prevailed from the south to west; and the coldest year was 1849, when the winds prevailed from north to east.

The barometer ranges on an average from 30·1507 to 29·2190 ins.; the mean range is therefore ·9317, but the full range in ten years is 1·347. Mean height for the month 29·7459 ins.

The prevailing winds are the class from west to north; the average of ten years being north to east 7·6, east to south 6·4, south to west 7·9, west to north 9·1.

The mean rain or melted snow is 2·8976 ins., falling on an average on 4 nights and 9 days, or a total of 13 through the month. The snow falls on 2 days on an average, and a mean depth of 1 inch. The heaviest storm was in 1844, when it snowed 4 ins. in one day. There are ten nights of frost upon an average, giving 31 mean degrees of frost. The greatest number, 58, were in 1843, and the least number, 8, were in 1848.

Hail fell once in this month in 1850, and once in 1852.

June.—Length of day in the middle of the month is 15 hours 20 minutes. Mean of greatest heat by day 69°·99, of greatest cold by night 46°·63; difference, or solar variation, 23°·36.

Mean temperature of the month 58°·29; difference in the mean lunar variation 7°·4. The warmest year was 1847, when the wind prevailed from the east to south; and the coldest year was 1851, when the wind prevailed from north to east.

The barometer ranges on a mean from 30·0871 to 29·2600 ins.—difference ·8271; but the full range extends to 1·063 in ten years. Mean height for the month is 29·6739 ins.

The prevailing winds are the class from south to west; the average of ten years being north to east 7·5, east to south 5·4, south to west 9·4, west to north 7·7.

The mean rain is 2·1539 ins., falling on an average on 4·5 nights and 9·4 days, or a total of 14 days through the month.

No snow falls in this month, and there are upon an average 3·8 nights of frost, but only occasionally, causing the thermometer on the house to fall below 32°, and giving a mean of 2°·15 of frost.

Hail fell once in this month in 1844, and once in 1848.

July.—Length of the middle day about 15 hours. Mean highest temperature by day 77°·80, mean lowest by night 54°·92. Solar variation 22·88.

Mean temperature of the month 65°·94; difference in the mean lunar variation 6°·8. The warmest year was 1849, when the wind prevailed from the south to west; and the coldest year 1851, when the wind prevailed from south to west.

The barometer ranges on a mean from 30·0662 to 29·3094 ins.—difference ·7568; but the full range extends to 1·162 in ten years. Mean height for the month 29·7104 ins.

The prevailing winds are the class south to west; the average of ten years being north to east 5·9, east to south 5·2, south to west 14, west to north 5·9.

The mean rain is 3·0210 ins., falling on an average of 5 nights and 9·6 days, or a total of 15 days through the month.

No snow falls in this month, and on an average there are ·5 nights of frost, but not causing the thermometer on the house to fall below 32°.

Hail fell once in this month in 1844.

August.—Length of the middle day about 13 hours 50 minutes. Mean highest temperature by day 76°·34, mean lowest by night 55°·39. Solar influence 20°·95.

Mean temperature of the month 65°·85; difference in the mean lunar variation 5°·1. The hottest year was 1843, when the wind prevailed from the S.W.; and the coldest year 1850, when the wind prevailed from north to east and south to east for half the month.

The barometer ranges on a mean from 30·1206 to 29·3872 ins.—difference ·7334; but the full range extends to 1·096 in ten years. Mean height for the month is 29·7699 ins.

The prevailing winds are the class from south to west; the average of ten years being north to east 6, east to south 6·4, south to west 10·6, west to north 8.

The mean rain for this month is 4·4299 ins., falling on an average on 4·9 nights and 9·2 days, or a total of 14 days through the month. In 1848 it rained 6·328 ins. in four successive days.

No snow falls in this month, and on an average there are 0·5 nights of frost, but not causing the thermometer on the house to fall below 32°.

Hail fell once in this month in 1843, and again in 1851.

September.—The length of the middle day is about 12 hours 20 minutes. The heat on a mean rises to 65°·64 and falls to 46°·59, making a solar variation of 19°·05.

Mean temperature of the month 56°·09; difference in the mean lunar variation 7°·3. The hottest year was 1846, when the wind prevailed from south to west 17 days; and the coldest year was 1843, when the wind prevailed from west to north for 13 days.

The mean temperature of nights in this month correspond very nearly to those of the month of June, but the days average 4°·5 colder.

The barometer ranges on a mean from 30·1617 to 29·1381 ins.—difference 1·0236; but the full range extends to 1·530 in ten years. Mean height for the month is 29·7671 ins.

The prevailing winds are from south to north; the average of ten years being north to east 5·4, east to south 4·9, south to west 10, west to north 9·7.

The mean rain for this month is 3·0048 ins., falling on an average on 3·8 nights and 8·6 days, or a total of 12·4 throughout the month. On the 8th September 1850 it rained 3·955 ins. in 24 hours, causing a great freshet in the rivers, which did much damage by carrying away several bridges.

A little snow fell once in this month in 1851, and on an average there are five nights of frost, giving 3°·9 mean of frost.

Hail fell once in this month in 1846, 1851, and 1852.

October.—The middle day in this month has the sun for 10 hours 48 minutes. The mean of greatest heat by day is 53°·882, and of greatest cold by night 38°·526; the solar variation 15°·356.

Mean temperature for the month 46°·34; difference in the mean lunar variation 4°·4. The hottest year was 1851, when the wind prevailed from south to west 15 days; and the coldest year was 1847, when the wind prevailed from the north to west 11 days, and south to west 12 days.

The barometer ranges on a mean from 30·3173 ins. to 29·0121 ins.—difference 1·3052 in.; but the full range extends to 1·924 in. in ten years. Mean height for the month 29·7657 ins.

The prevailing winds are from south to north; the average of ten years being north to east 5·3, east to south 5·7, south to west 10·2, west to north 9·8 days.

The mean rain for this month is 5·7760 ins., falling on an average on 5·8 nights and 9·7 days, or a total of 15·5 throughout the month. In 1843 it rained 10·58 ins. on 20 days during this month.

Sometimes as much as 3 ins. of snow fall during two or three days in this month, but it does not remain long on the ground. On an average there are 10·4 nights of frost, giving 35°·3 of frost.

Hail fell once in this month in 1844, 1846, 1848, 1849, 1851 and 1852.

November.—The length of the middle day is 9 hours 26 minutes, or half an hour longer than in London. The average temperature rises to 42°·25, and falls to 30°·35, making a solar variation of 11°·90.

Mean temperature of the month 36°·27; difference in the mean lunar variation 10°·5. The hottest year was 1849, when the wind prevailed from west to north 15 days; and the coldest year was 1843, when the wind prevailed for 13 days from west to north, and 12 days from north to east and east to south. The mean temperature of this month corresponds with April, but the days are 4° colder, and the nights about 3° warmer.

The barometer ranges on a mean from 30·2686 to 28·8229 ins.—difference 1·4457; but the full range extends to 2·032 ins. in ten years. Mean height for the month is 29·6873 ins.

The prevailing winds are westwardly; the average of ten years being north to east 3·9, east to south 4·6, south to west 10·3, west to north 11·2.

The mean rain for this month is 4·7456 ins., falling on an average on 4·7 nights and 11·2 days, or a total of 15·9 throughout the month. Snow falls generally on six days, averaging 9½ ins. in depth. The greatest storm was 16 ins. in one day in 1852, but it did not remain on the ground. It hailed once in 1850. On an average there are 20·8 nights of frost, giving 127°·5 of frost.

December.—The length of the middle day is 8 hours 40 minutes. The average temperature rises to 29°·876, and falls to 18°·656, making a solar variation of 11°·22. Mean temperature for the month 24°·21; difference in the mean lunar variation 11°·8. The hottest year was 1847, when the wind prevailed from the south to west 12 days; and the coldest year was 1851, when the wind prevailed 13 days from west to north.

The barometer ranges on a mean from 30·3433 to 28·7499 ins., being a difference of 1·4457; but the full range extends to 2·081 ins. in ten years. The greatest depression, 28·410, occurred in this month in 1848. Mean height for the month is 29·6885 ins.

The prevailing winds are westwardly. The average for ten years is north to east 3·7, east to south 4, south to west 10·8, west to north 12·5.

The mean rain for this month is 4·8795 ins., falling on an average of 5·4 nights and 12·2 days, or a total of 17·6 throughout the month.

Snow falls generally on 13 days, averaging 2 ft. 2½ ins. The greatest storm was in 1846, when 18 ins. fell in 12 hours. It generally hails once or twice during this month. On an average there are 28 nights of frost, giving 428°·7 of frost.

Table of Meteorological Means for Ten Years, at the Albion Mines, Nova Scotia, North
120 feet above the sea.

	Jan.	Feb.	March.	April.	May.	June.	July
Thermometer, mean of two extremes	18·84	19·52	26·98	36·90	48·44	58·29	65·94
Thermometer, at noon	25·466	28·075	36·135	46·240	59·287	69·990	77·8
Thermometer, at night	12·180	10·955	17·850	27·637	37·630	46·630	54·9
Barometer, at noon	29·6958	29·6866	29·6720	29·7022	29·7459	29·6739	29·71
Nights of rain or snow	5·1	4	4	4·3	4	4·5	5·1
Days of rain or snow	11	9	10	8·3	9·5	9·4	9·6
Quantity of rain or melted snow ..	3·3814	3·2673	4·3963	2·6500	2·8976	2·1539	30·21
Days of snow	12·1	10·5	11·5	6·7	1·9	....	....
Quantity of snow in inches	20·86	18·54	24·90	9·33	1·25	....	....
Days of wind from N. to E.	3·8	4·2	5·5	7·7	7·6	7·5	5·9
Days of wind from E. to S.	4·4	4·9	5·5	3·5	6·4	5·4	5·2
Days of wind from S. to W.	7·4	6·9	7	7·4	7·9	9·4	14
Days of wind from W. to N.	15·4	12·3	13	11·4	9·1	7·7	5·9
Days clear, or without clouds	....	·4	·2	1·2	·4	....	....
Days cloudy	27	25·2	27	24·6	28·6	29	30·4
Days overcast, or without blue sky	4	2·8	3·8	4·2	2	1	·6
Nights of frost..................	29·3	27·2	28·3	24·3	10·7	3·8	·5
Nights below zero	6·7	7·7	2·8	·2	....	....	....
Degrees of frost below 32 degrees..	623	600·4	453	164·8	31·2	2·15	....
Lightning and thunder	·4	·1	·5	·3	1·3	3·7	6·1

Climate of the Albion Mines, Nova Scotia, North America, compared

Station.		Latitude North.	Long.	Height of Station.	Mean Mo						
Name of place.	American Continent.				Jan.	Feb.	March.	April.	May.	June.	July.
Albion Mines ..	N. Scotia ..	45° 34′ 30″	62° 42′W.	120	18°·84	19°·52	26°·98	36°·90	48°·44	58°·29	65°·94
Halifax	N. Scotia ..	44 39 0	63 38W.	..	20	18	25	30	40	50	63
Charlotte Town..	P. E. Island	46 12 0	63 0W.	..	17·9	23·5	27·8	37·6	51·6	60·2	69·5
Fredericton	N. Brunswick	45 57 0	66 45W.	..	17	24	33	40	37	48·5	65·5
Montreal	Canada	45 31 0	73 25W.	..	15·01	19·22	30·98	45·82	60·49	69·25	73·87
Ft. McKinack ..	Lake Huron	45 51 0	85 05W.	728	20·13	15·76	26·09	37·66	46·25	56·32	63·19
	European Continent.										
Vienne	France	45 32 0	4 53 E.	..	36·28	38·98	49·10	55·63	63·95	69·13	72·95
Triest..........	Germany ..	45 38 0	13 46 E.	..	38·26	39·45	44·87	52·93	63·28	69·04	72·61
Milan..........	Italy	45 28 0	9 11 E.	720	33·22	36·30	45·88	54·66	64·09	70·66	74·75
Venice	Italy	45 26 0	12 21 E.	20	35·29	38·98	46·15	54·73	63·39	70·39	73·07

America. Latitude 45° 34′ 30″ North; Longitude 62° 42′ West from Greenwich.
6 feet from the ground.

ug.	Sept.	Oct.	Nov.	Dec.	Year.	Winter.	Spring.	Summer.	Autumn.
5·85	56·09	46·34	36·27	24·21	41·974	20·857	37·44	63·36	46·243
6·340	65·640	53·882	42·250	29·876	50·915	27·806	47·220	74·710	53·924
5·390	46·590	38·526	30·350	18·656	33·109	13·930	27·706	52·313	38·489
29·7699	29·7671	29·7657	29·6873	29·6885	29·7137	29·6900	29·7067	29·7181	29·7400
4·9	3·8	5·8	4·7	5·4	56·2	14·5	12·3	14·5	14·3
9·2	8·6	9·7	11·2	12·2	117·4	32·2	27·8	28·2	29·5
4·4299	3·0048	5·7760	4·7456	4·8795	44·9676	11·5282	9·9439	9·6048	13·5264
....	·2	1·5	6·1	12·9	63·4	35·5	20·1	....	7·8
....	....	·6	10·29	25·69	111·46	65·09	35·48	....	10·89
6	5·4	5·3	3·9	3·7	66·5	11·7	20·8	19·4	14·6
6·4	4·9	5·7	4·6	4	60·9	13·3	15·4	17	15·2
10·6	10	10·2	10·3	10·8	111·9	25·1	22·3	34	30·5
8	9·7	9·8	11·2	12·5	126	40·2	33·5	21·6	30·7
....	·16	·34	....	·16	2·86	·56	1·80	....	·50
30·2	28·5	27	26·5	26·5	330·50	78·70	80·20	89·60	82
·8	1·34	3·66	3·5	4·34	32·04	11·14	10	2·40	8·50
·5	5	10·4	20·8	28	188·8	84·5	63·3	4·8	36·2
....	....	....	....	2·3	19·7	16·7	3	....	....
....	3·9	35·3	127·5	428·7	2470	1652·1	649	2·15	166·7
3·8	1·2	1	·2	·5	19·1	1	2·1	13·6	2·4

with other places of, or near the same degree of North Latitude.

mperature.				Mean of Year.	Seasons.				Extremes.		Years of Observation.	Hours of Observation.	Authority.
ept.	Oct.	Nov.	Dec.		Winter.	Spring.	Summer	Autumn	Summer and Winter.	Hot and Cold.			
6·09	46°·34	36°·27	24°·21	41°·94	20°·86	37°·44	63°·36	46°·24	42°·50	47°·10	10	Sunrise and 2 p.m., or extremes.	H. Poole.
1	51	38	25	40·08	21	31·67	61	46·67	40	52	2	N. Y.	Dove.
9·5	45·8	37·5	28·6	43·9	23·3	39	65·8	47·6	42·5	51·6	1	....	Boston Daily Advertiser.
1·5	47·5	31	13·5	40·69	18·17	36·67	61·25	46·67	43·08	52·75	..	....	Montgomery
1·15	48·66	34·43	19·13	45·57	17·79	45·76	71·40	48·08	53·61	68·56	10	7a.m.&3p.m.	Dove.
5·15	43·40	33·20	23·15	40·37	20·08	36·69	61·33	43·39	41·25	47·74	7	Sunrise, 2 p.m., 9p.m.	U. S. Army.
75	54·95	43·25	41	55·36	38·75	56·23	71·83	54·65	33·08	37·12	6	....	Cotte.
23	57·22	47·62	40·60	55·30	39·44	53·69	71·39	56·69	31·95	34·35	15	7a.m., 2p.m., 9 p.m.	Schouw.
47	56·95	47·08	36·57	55·19	36·03	54·88	73	56·83	36·97	41·53	59	Sunrise, and 2 to 3 p.m.	Dove.
27	56·66	44·65	39·92	55·44	38·06	54·76	73·06	55·86	35	39·78	7	Sunrise, 2¼ p.m., 9p.m.	Schouw.

Albion Mines, Nova Scotia.

Daily Mean Temperature for 11 years.

	Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	6 feet above ground in shade, N.E.
1	22·56°	13·22°	21·59°	33·81°	41·36°	49·00°	60·41°	69·73°	60·00°	50·00°	42·13°	27·45°	Monthly Mean.
2	18·00	16·13	21·27	30·50	45·00	52·32	60·59	69·18	60·77	47·77	44·05	28·13	
3	22·63	21·54	20·81	32·86	43·36	55·41	60·68	67·86	63·09	49·82	44·22	27·22	19·85
4	20·59	22·33	19·36	34·95	43·64	56·59	62·18	67·41	64·18	48·23	43·54	30·50	19·90
5	20·04	24·81	21·09	35·73	43·45	56·09	64·77	67·73	61·59	49·41	40·27	32·86	27·41
6	20·36	24·04	20·54	34·04	45·59	55·77	65·13	65·86	59·91	49·63	40·50	26·32	37·378
7	20·72	24·04	22·32	36·45	47·27	54·27	63·55	65·23	63·45	47·13	37·09	26·27	48·58
8	24·45	21·45	25·22	38·27	49·59	56·32	64·18	66·04	61·86	47·82	36·91	27·59	58·142
9	19·59	19·22	29·91	38·73	48·95	56·00	65·59	67·41	57·64	44·36	35·62	26·82	66·10
10	24·04	20·54	25·22	35·63	46·95	56·91	66·41	68·73	55·45	48·09	37·14	28·36	65·19
11	20·77	21·31	24·32	35·82	47·86	56·41	68·91	68·00	57·64	47·91	35·54	26·41	56·053
12	18·54	21·59	24·00	34·04	47·59	52·95	67·50	67·54	57·18	47·26	33·50	25·18	46·282
13	19·77	15·18	26·41	35·45	43·50	53·04	67·18	64·77	56·31	51·00	34·90	24·00	35·588
14	23·63	16·27	29·27	37·09	49·05	56·13	66·27	67·09	54·76	48·86	32·36	20·68	24·47
15	20·77	19·54	25·17	37·63	50·23	57·82	66·41	66·41	54·50	45·50	32·54	24·95	$\frac{1}{12}$)504·943
16	20·77	18·72	23·27	36·54	53·09	57·18	66·72	62·00	54·18	43·59	32·90	25·73	
17	18·95	19·67	27·32	36·68	53·41	56·86	67·95	64·82	53·00	44·22	34·18	26·45	42·0786
18	18·50	18·63	26·63	34·86	49·46	59·77	69·72	64·04	53·27	46·59	36·32	25·95	
19	12·91	16·18	28·91	37·36	46·41	63·73	66·82	64·22	56·00	49·63	36·45	21·23	
20	11·04	17·22	28·45	38·63	51·00	64·04	69·13	62·04	55·00	46·86	35·90	23·50	
21	16·95	19·50	32·54	41·50	49·04	62·41	70·68	61·36	59·41	43·54	35·73	21·00	
22	14·68	19·95	30·45	41·12	49·39	62·41	72·82	62·77	54·86	44·64	35·09	13·68	
23	14·68	23·09	28·18	40·59	54·32	63·04	71·77	63·91	52·36	48·19	34·82	19·41	
24	19·04	22·41	31·72	40·04	51·23	61·41	67·32	62·36	52·45	44·96	35·63	22·59	
25	24·27	20·41	30·50	38·54	51·27	62·41	65·45	63·86	50·18	44·95	32·73	21·11	
26	24·68	21·45	32·09	39·91	51·45	59·77	65·45	62·59	49·04	43·59	34·68	21·66	
27	16·50	21·68	35·09	40·63	51·18	60·50	64·63	62·82	51·09	43·50	29·45	18·33	
28	12·50	16·72	33·68	41·00	49·04	61·18	64·68	63·41	49·41	42·04	29·32	20·50	
29	18·54	20·50	34·81	42·00	51·36	61·41	64·23	63·50	51·32	39·59	25·90	26·32	
30	21·86	....	35·04	40·95	51·41	63·13	64·91	64·41	51·68	44·32	28·04	23·95	
31	13·25	....	34·64	....	49·59	....	67·32	63·86	....	41·86	....	24·41	
	19·85	19·90	27·41	37·378	48·58	58·142	66·10	65·19	56·053	46·282	35·588	24·47	

On some Simultaneous Observations of Rain-fall at Different Points on the same Mountain Range. *By* W. J. MACQUORN RANKINE, *C.E., F.R.S. L. & E.*

The observations referred to were made daily and simultaneously, for a period of 151 days, at two points, distant 2¼ miles from each other, and differing by about 200 feet in elevation, on the north-west slope of the Pentland Hills, near Edinburgh. The lower gauge, designated as H, was 700 feet above the sea, and 3¼ miles from the chain of summits of the hills; the higher gauge, designated as G, 900 feet above the sea, and 1½ mile from the chain of summits. The total rain-fall at G during the period of observation exceeded that at H in the ratio of 1¼ to 1. For short periods of rainy weather, of from two to eleven days, the ratio deviated from this average value in a somewhat irregular manner, showing, however, a tendency to increase on the approach of winter; for periods of a calendar month the deviations from the mean ratio were much smaller. To throw some light on the question, whether the greater depth of rain-fall at G, as compared with H, was chiefly owing to the higher elevation of the ground, or to the greater proximity to the summits of the hills, the depth of rain-fall at these points was compared with the depth as published by Mr. Beardmore, at the Glencorse Reservoir, on the south-east side of the range, at a point designated by F, only 30 feet higher than H, but almost surrounded by the highest summits of the chain. Notwithstanding the lower level of F as compared with G, the rain-fall at F was somewhat the greater; a fact which seems to indicate that the vicinity of high summits has a greater influence than mere elevation. The gaugings of the flow of the streams by Mr. Beardmore near F, and by the author near G, show that the rain-fall nearer the summits than these points must have been greater still. The rain-fall at H exceeded that at a point in the immediate vicinity of Edinburgh, 230 feet above the sea, in the ratio of 1 to 1·26.

On Auroræ Boreales observed at St. Ives. By J. King Watts.

Instruments.

On an easy Method of making thin Glass Cells for mounting Microscopic Objects in Fluid. By C. Brooke, *M.A., F.R.S.*

The durability of thin glass cells, compared with cells consisting of a ring of cement or varnish laid on the slide by a brush, is well known to microscopists; but they have been hitherto somewhat difficult of construction, and therefore expensive. The proposed mode of making them consists in clamping the piece of thin glass between two pieces of gun-metal, having each a cylindrical hole, but one of the holes being 0·04 or 0·05 inch larger in diameter than the other. The pieces are clamped by two screws, the holes being kept concentric by two steadying-pins. One of the opposed surfaces is ground very flat, and the other has a narrow raised rim, about 0·1 inch wide, covered with very thin leather surrounding the hole, to ensure a firm and uniform pressure round the intended aperture. After scratching round both sides of the glass revealed by the holes with a writing diamond, the circular piece may be pushed out without any risk of cracking the remainder of the glass.

On Photographic Drawings of Meteorological Instruments adopted by the Council of the British Meteorological Society. By John Lee, *LL.D., F.R.S.*

These accurate photographs, taken by Mrs. Glaisher, were of the standard barometers, thermometers wet and dry bulb, and other meteorological instruments, with their stands and arrangements, as used and recommended by the British Meteorological Society. The Standard Barometers are those made by Mr. Barrow, of Oxendon Street, London, and the several thermometers and their stands by Messrs. Negretti and Zambra, as is also the rain-gauge constructed by Mr. Glaisher.

On a Method of Manufacturing Cylindrical Lenses. By Prof. Sturm.

The stages through which the science of optics has passed since Euler's discovery, nearly 100 years ago, of the principles of achromatism, have not proved the infallibility of the system of the spherical lenses for optical purposes. I now, however, call attention to cylindrical lenses ground by machinery, invented by myself, which is done with such perfection that I humbly hope they may be the means of opening a new field to science. In the first place, that the cylindrical principle, in general, is superior to the spherical, will appear from the circumstance, that a perfectly cylindrical lens is free from the defects of spherical aberration, and that the opposite rectangular planes combine in forming ellipses in their intersections, and consequently show a greater precision, distinctness and luminousness, and less contraction of dimensions; they therefore admit of enlarged visual angles. The cylindrical system, moreover, renders it practicable to form curves of all kinds, for instance, paraboles, hyperboles, ellipses, &c., which is impracticable in the spherical system. In the second place, the aforementioned machine is so constructed that every lens, even for spectacles, appears centred, since the cross lines of the two planes pass through the middle, whilst the centralization of spherical object-lenses is, as known, very difficult and imperfect. This defect arises both in the best spherical and cylindrical lenses from their being hitherto ground by hand; the imperfection becoming more evident in the latter than the grossest defects in the former; and this doubtless is the reason why science has not bestowed more attention on cylindrical lenses. No one would expect the formation of a perfectly circular cone without the instrumentality of a turning lathe; and, in like manner, what the turning lathe is to this or other articles to be finely rounded, the machine I wish to introduce is for optical lenses; hence, too, the advantage of the perfectness of its productions, and also the rapidity of the manufacturing process. In the third place, in order to prove the better preservation of the eyes by the use of cylindrical lenses than by the spherical, it is only necessary to observe that two cylindrical planes, intersecting each other at right angles, have the effect of neutralizing the defect of spherical aberration; whilst two parallel spherical planes produce the effect of doubling the imperfection: moreover, we need only to advert to the structure of the eye in man and other animals, which is not spherical, nor achromatic, and is nevertheless free from the defect of aberration:—it is, rather, the elliptic shape, which in creation appears to predominate, as for instance, in the planetary orbits, in magnetic currents, &c. And, since the effect of a cylindric lens approaches that of an ellipse, and since, moreover, an optically diseased eye shows a still greater departure from the spherical form, it is equally apparent that a perfect cylindric lens is the best adapted, as the passage of the rays not only takes place in and about the centre, but on every point of the surface, thus effecting an equable and perfectly regular distribution of light on all points.

On Natural Occurrences that impair the Vision of good Telescopes.

By CORNELIUS VARLEY.

The author remarks, that everything moving on the earth causes vibrations; the result is tremors, too fine to be known till high magnifying proves their existence, and the very best braced stands convey them to the telescope. He stated a fact:—On placing his ear close to the ground on Bromley Common, he heard, first a heavy waggon about a mile off; second, a one-horse cart; third, a stage coach in Bromley two miles off: their differing distances and approach were indicated. These he afterwards met in reverse order from their differing speed. This proved tremors in the earth which would affect high powers, and from the number of greater causes than these he inferred the earth's surface to be rarely or never free from such. He showed two means of insulation so as to avoid them:—First, cushions of wool or thick india rubber under three feet. Second, supporting the telescope by pulley blocks (which has been done for Newtonians with success), such blocks and ropes being quite incapable of receiving or transmitting vibrations or tremors, and being therefore the most perfect insulators. The high northern support of polar axes receives tremors from the earth and enlarges them upwards, but heavy top bars leaning against them might be made real discords or dampers. Sounds of all sorts, percussions, winds, the sea roaring, all cause vibrations that act on the materials of both telescope and stand, and impair their performance. All these cause the most rapid alternations from dense to rare in the atmosphere, which, added to the ever-varying density of the air from vapour, temperature, pressure, and currents, so disturb the passage of light, as to make the stars twinkle into a much larger diameter than they are known to possess. This twinkling affects all features that are equally small, and would ultimately limit the definition of high powers, if we did not remove as much as possible above all such interferences as fogs, sounds and the like. From his own observations at the height of 600 feet, the fogs began rapidly to disappear, and to afford much clearer vision through the atmosphere.

Navigation.

On the Loss of the 'Tayleur,' and the Changes in the Action of Compasses in Iron Ships. By the Rev. W. Scoresby, *D.D., F.R.S. &c.*

There were perhaps few subjects, he said, of more practical consideration and importance than the one which he had the honour of submitting to the Section on that occasion; and if of more importance and consideration in one place than another, he might say the port of Liverpool ought to stand pre-eminent in respect of the consideration due to compass guidance in iron ships.

The importance of determining not merely the principles which occasion the original development of the magnetic condition in iron ships, but also of determining the principles upon which changes in that development would take place, was, of course, proportionate to the extent to which iron was employed in the construction of vessels navigating the ocean; and so great had been the increase in the adoption of iron as a material for ship-building, that in many ports where they were accustomed to build a large number of vessels, it would be found that nine-tenths of the vessels building were entirely vessels of iron. He did not know but that pre-eminence of proportion might exist here; but, at all events, the application of iron as a material for the construction of ships was rapidly increasing. There were certain principles connected with the navigation of iron ships which were universally admitted. Those principles were, that iron, being more especially disposed to the magnetic condition, was a material, of course, calculated above all others to disturb the action of the compass on board the ship. Again, it was also admitted, that there were difficulties in the navigation of iron ships, arising not merely out of the original or primary, magnetic condition and disturbing influence of the iron, but also in respect of certain changes which had been held as mysterious—changes which took place not unfrequently in regard to ships whose magnetic condition had been supposed to be very well ascertained. It would be the leading objects of the communication he was about to make, to endeavour to develope the principles on which the peculiar magnetic condition of iron ships was distributed, and to show the principles and circumstances under which changes must necessarily take place. The melancholy case of the 'Tayleur' afforded an example of the most impressive kind to connect with the general bearing of this important subject. As many of the Section might not be aware of the circumstances connected with the wreck, he would sketch, very hastily, a few points necessary to carry on the subject.

The ship 'Tayleur,' a new vessel, bound to Australia, sailed from Liverpool on Thursday the 19th of January of the present year. She was 1979 tons burthen, new measurement, and she had on board about 458 passengers,—the crew and passengers altogether making a total of 528 persons. She left the Mersey about noon on the Thursday to which he had referred. The pilot left her between seven and eight o'clock in the evening in a position between Point Lynas and the Skerries.—[The Rev. Doctor here referred to a map, which he said had been kindly afforded him for the occasion by Mr. Towson, and which illustrated the positions he referred to in the course of his paper.]—On Friday she encountered very heavy weather; and about eight o'clock on the following (Saturday) morning it was for the first time ascertained that there was a material difference between the compasses. There were three compasses on board; but he would only refer to two of them. One of the two was near the helmsman, and was the one by which he steered; and the other was near the mizenmast. Both of these compasses had been, what is called, *adjusted* by permanent magnets; so that if the principle of adjustment had been correct, they should not either have changed or differed from each other. Trusting to the compass near the helmsman, the captain had the idea firmly impressed upon his mind that he was sailing fairly down, almost mid-channel; at all events, in a good position for navigating the Irish Channel. The other compass indicated a difference of about two points. The captain, however, judging from certain indications which he had noticed previously, assumed that the wheel compass was the correct one. In the course of a few hours—about half-past eleven o'clock on the same morning—the wind having increased, and a heavy sea setting up the Channel, the ship made rather a rapid progress, when they came suddenly in sight of land on the lee beam, in such a position that there was necessarily a great difficulty,—in this case (according to the measures pursued) an insurmountable difficulty—in avoiding the land. An attempt was made to wear the ship round. This failed, and then an attempt was made to use the anchors to bring her up. Both the cables snapped on the occasion, and the ship was then left helpless, driving broadside upon the rocks of Lambay Island. The result was the fearful catastrophe with which most persons were acquainted; namely, the loss of about 290 lives. Out of 100 females who were in the ship only three escaped upon that melancholy occasion. Investigation into the cause of the accident was naturally suggested, and the Board of Trade instituted inquiries in two departments; one by means of Capt. Walker, of the Navy, the other by means of the Marine Board of Liverpool, of which Mr. Towson was the Secretary. Capt. Walker, in his Report, ascribed the loss of the 'Tayleur' to the captain's supposition that the compass by the helm was correct. The Local Marine Board came to a conclusion which he would notice by an extract from their Report. After stating that Capt. Noble had given very great attention to the ascertaining of the correctness of his compasses and verifying their action on different occasions, they proceeded in their Report to say that "notwithstanding these precautions, it appears to this Board that the 'Tayleur' was brought into the dangerous position in which the wreck took place through the deviation of the compasses, the cause of which they (the Marine Board) had been unable to determine." The Board called particular attention to the fact, "that numerous instances had been brought under their consideration of compasses having proved greatly in error on board both wooden and iron ships in the navigating of the Irish Channel, which deviation, it continued, was not accounted for by any theory hitherto propounded."

Dr. Scoresby proposed to show that there were principles which not only reasonably, but, he would say, demonstrably established the leading principles on which not only the original development of the magnetism of iron ships was distributed, but likewise the circumstances under which changes in that development must necessarily take place. This subject was brought by him before the Meeting of the British Association at Oxford, in 1847, when he read a paper, showing experimentally and illustratively that the adjustment of the compasses of ships by fixed and permanent magnets was not only delusive, but calculated to become the occasion of serious danger. And if the opinions given by Capt. Walker and the Liverpool Marine Board were true—if there was a relation between this catastrophe and the misguidance of the compasses—then it would be easy to show that had the compasses not been corrected or adjusted by means of permanent magnets, the captain of the 'Tayleur' would have been abundantly warned, and therefore in a far better position for securing the safety of the ship.

It was a matter well known, not merely that iron became magnetic by virtue of the inductive influence of the earth, but, as he had elicited and explained the fact so long ago as the year 1820, in communications to the Royal Society of Edinburgh, that the magnetism so developed could be augmented, controled, or destroyed by mechanical action. Proceeding on these principles, he had shown in his communication at the Meeting of the British Association in 1847, the necessary instability of the magnetic distribution in ships built of iron; and thence inferred that the plan of correcting, or adjusting, the compasses on board such ships by the antagonistic action of steel magnets, must be delusive and might be extremely dangerous.

In the case now more particularly referred to, that of the 'Tayleur,' where the compasses were adjusted by fixed magnets, the result (according to the Reports published by the Board of Trade) was just in accordance with the views he had thus stated at Oxford—the ship's magnetism did obviously change, and the permanent magnets seriously augmented the new errors produced on the compasses. And though in this instance the direction of operation of the adjusting magnets was but incidental, the effect, so far as the authorized reports may guide us, was fatal;—so that had there been *no* adjusting magnets the captain would have been guarded against the delusion that he was making a fair course down the Channel, and would have been in a very different position as to safety.

The magnetic condition of iron ships and the circumstances under which the chief intensity of their magnetic action was developed, could be well illustrated by a few experiments with an iron bar—as first, showing the simple effects of the earth's induction, and secondly, the augmenting or changing influence of mechanical violence. Thus, an iron bar, entirely neutral as to its molecular magnetism, as shown by its being devoid of influence when placed horizontally, in an east and west line, near a compass, became strongly magnetic when placed upright, or proximately so. But its polarity was reversed by turning it with the contrary end downwards, and it again became neutral when laid on the horizontal east and west line. If the same bar, however, while held in an upright position, or inclined in the axial direction of the earth's magnetism, were subjected to percussion or other mechanical violence, not only did its magnetism become much more powerful than that of simple induction, but it strongly exhibited its augmented polarity, when placed in the east and west equatorial position, and, however it might be moved about and swung round, its polarity remained the same.

Having proved these two propositions by experiment, Dr. Scoresby went on to apply them to the case of iron ships, and to point out that, in consequence of the percussive action to which the material was exposed while the ships were in course of construction, it became as intensely magnetic as it was possible for malleable iron to be. This augmented magnetism, however, was not permanent or fixed, but, under different circumstances, as to the relative directions of the ship's magnetism and that of the earth, was easily changeable, and liable necessarily to be changed. The magnetism developed by mechanical violence could be readily neutralized or changed, under a proper change of conditions, by other processes of mechanical violence. Thus, if the bar of iron magnetized by hammering were held in the reverse direction from that in which the magnetism had been developed, and again hammered, the polarity would not only be altered, but reversed. Again, after well hammering the bar in a vertical position, let it be quietly reversed, the lower end, or north pole, as hammered, now being upwards, and let one of its extremities be then presented to a delicate compass; the deviating influence in this case would be but small, perhaps a few degrees only, from the influence of the earth's magnetism being now opposed to the augmented magnetism of the bar. If, while held in this position, a single blow were struck on the bar with a hammer, the needle would be seen to fly round as if by magic, and settle at a point of deviation perhaps four or six times as great as before.

The result of another experiment which he was in the habit of showing with elongated plates of iron, to elucidate the phænomena of mechanical vibrations or violence, was still more remarkable. Here he should employ a couple of thin iron plates laid flat on each other,—and it would be seen, when their condition was neutral, that, though held close to the compass, horizontally east and west, there was no action whatever on the needle. But after holding the plates upright and bending them, however slightly, or striking them with the hand, or merely giving them a vibratory shake, and then presenting them as before to the compass, the iron was found to have become very strongly magnetic, the end which was downward repelling the north pole of the needle. Reversing the position of the plates, while held upright, let the vibratory action be repeated, and the end formerly repelling will now be found to attract the north pole. Repeating the vibratory action, while the plates were held horizontally in an east and west line, the magnetism would be found, on bringing the plates to the test, to have disappeared, all action on the compass having gone.

To meet objections which might be probably offered against the application of his experiments on thin plates and small bars to the case of iron ships, he had made experiments on rolled iron plates, of the same kind as those of which ships were generally built; and had ascertained that the magnetism in these also was changeable and controlable like that in bar iron, under the requisite change of position, by vibratory or percussive action. He had also made experiments on a portion of a plate cut out of the side of a ship recently built, with effects exactly similar. The general results of his experiments went to the establishing of the fact, that, besides the two denominations of magnetism ordinarily received, that of simple terrestrial induction and that of permanent independent magnetism, there was another denomination corresponding with neither; not being absolutely controlable, like the former, by terrestrial influences, nor capable, like the latter, of resisting all kinds and modes of mechanical violence. To this third denomination he had given the name of *Retentive Magnetism*.

Dr. Scoresby then exhibited experiments with three sets of plates, two of iron and one of steel, for the illustrating of these several qualities of magnetism:—1. That of simple terrestrial induction by iron plates free from polarity, which became magnetic or changed their magnetism according to the position in which they were held. 2. Retentive magnetism, as illustrated by similar plates, which had been previously magnetized by bending and blows,—such magnetism appearing as if permanent when the plates were moved about, without being vibrated or bent. And 3rdly. Permanent magnetism, as illustrated by an elastic steel plate, which, however violently it was bent or struck or vibrated, or in whatever position, still preserved its magnetism unaltered. Now this retentive magnetism was the quality which had been prevalently considered as permanent; which, he was prepared to show, both by experiments on iron and facts of experience, was by no means a fixed quality. On the contrary, the long continued vibration of a ship under steam, and much more so the straining of a ship in a heavy sea, under the circumstance when the terrestrial induction might be acting in a very different direction from the original axial polarities of the ship, would be sufficient to change the direction of the magnetism originally developed in the course of her construction. Hence much would depend, in respect of the mechanical action of the sea, on the position in which the ship had been built, or on the direction of her polar axis prior to such mechanical action.

In the case of the 'Tayleur,' when he first heard of the catastrophe, and had read the evidence, he had stated to some friends at Torquay, that he would venture to predict that she had been built with her head easterly or north-easterly. He had found, on inquiry, she had been built with her head north-east. Here, then, were the precise circumstances for expecting a change in the ship's magnetic distribution. Having been built with her head to the north-east, she had a certain magnetic distribution accordingly, and when she began to strain, with her head westerly, that distribution was necessarily changed, and the first effect of it had been to produce a great difference in the two compasses adjusted by fixed magnets. If the captain had been aware of the changes which might, and most probably would, take place when the ship began to strain in a different position from that in which she had been built; if he had known that the compasses, having so large an original deviation as 60°, might vary as much as two, or three, or even four points, he would have known, of course, that he must place no reliance upon them. It did not follow, however, that compasses were of no use, because, under certain circumstances, they were liable to change. They should be, and were, of great use for all that. But what he wished to impress upon them was, that by attempting to adjust a changeable influence by a permanent influence, they were liable to produce an aggravation of error. It was most important, therefore, for safety in navigating these vessels, that captains should be made aware of the liability of the compasses to change and so to mislead them; that they should know the circumstances under which, in accordance with natural laws regulating and applying the earth's inductive action, changes were most likely to occur; that they should be always watchful of opportunities for determining the true magnetic direction with reference to their compasses, by observations of the sun and stars; and that by providing a place for a standard compass aloft (on the plan he, Dr. Scoresby, had suggested and adopted in 1820), as far from the deviating influence of the body of the ship as possible, they might have guidance sufficient, with some small allowances, for steering a correct magnetic course. And with the precautions and means such as might thus be applied, he, Dr. Scoresby, did not doubt but that the difficulties, in respect of compass guidance, in the navigation of iron ships, might be mainly and practically overcome.

The general experimental results and the principles sought to be elucidated, were illustrated by a variety of references to actual cases of compass changes in iron ships.

An Inquiry into the Principles and Measures on which Safety in the Navigation of Iron Ships may be reasonably looked for. By the Rev. W. Scoresby, *D.D., F.R.S., Corr. Memb. Institute of France, &c.*

This paper, interspersed with numerous illustrative allusions, was in substance as follows:—His time, Dr. Scoresby remarked, was so limited in his paper on the loss of the 'Tayleur,' that he was obliged to leave off in the most critical position. He had pointed out the disease, but was obliged to hasten to a conclusion with scarcely a word of consolation, or being able to offer any remedial advice. The result was, that a gallant officer then present said to him, "Why, you have upset all our plans; you have told us compasses cannot be trusted. How are our iron ships to be navigated? Show us the remedy!" Though he, Dr. Scoresby, did not admit the responsibility to *give a remedy*, it would be his object to endeavour to point out the leading circumstances under which we may expect a fair measure of accuracy in compass guidance, and the circumstances to be watched against most eminently calculated to produce compass changes. But before entering on these points, he felt it important to revert, briefly, to the leading principles developed in his long-made investigations on the magnetism in iron, with reference to the compass action and its changes in iron ships. And this he was the more encouraged to do, because of the great change which had taken place in his position, as the suggester and promoter of certain scientific phænomena in this department, since his first paper on the subject was read to the British Association at Oxford in 1847.

It is now most gratifying to find, from the paper of Mr. Archibald Smith, a gentleman eminent as a mathematician, and having all the records of Her Majesty's ships, as to compasses, at command, that every essential principle, for which he had contended, as to the principles which affect the development and changes in the magnetism of iron ships, is admitted and supported. These principles, so supported by Mr. Smith, might (so far as he correctly understood his paper) be thus enumerated:—

1. That the magnetism of iron ships in its action on the compass, may be represented by a vertical and a horizontal iron or magnetic bar swinging round a compass; a mode of illustration which he, Dr. Scoresby, had adopted some years ago, and used in lectures, as well as in his publication of 'Magnetical Investigations,' of 1852.

2. That changes in the magnetic distribution and compass action in iron ships, which he had predicted, do take place.

3. That the changes which take place in a ship's magnetism by changes of magnetic latitude, lag behind the due influence, theoretically assumed, of terrestrial induction,—a fact inferred from the Admiralty observations which his, Dr. Scoresby's experiments, satisfactorily elucidated as a necessary consequence of the resistance in iron to change in regard to the denomination of *retentive* magnetism.

4. That there are influences in a ship, derived from the varieties of form and position (relatively to the compass) of particular masses of iron, which may act as *natural correctives.*

5. That the plan of correcting the deviation of iron ships by *fixed magnets* (unless in particular places or limited voyages) is unsafe, and in going to southern regions aggravates the error.

6. That the twisting or straining of the iron materials of a ship will tend, especially in ships recently launched, to alter the magnetic action on the compass.

7. That it requires time to effect the entire changes in a ship's magnetic distribution, which ultimately may, in regions distant from the place of building, be effected.

Hence, it may be added, all these particulars embodied and expressed in Dr. Scoresby's investigations, and now admitted and confirmed (as he has understood the paper) by Mr. Smith, leaves nothing of real objection to his (Dr. Scoresby's) results. And the whole of the results plainly go, he believes, to the establishment of a proposition, of the accuracy of which he has long endeavoured to convince those interested in the navigation of iron ships, that the magnetism of such ships is, in all its qualities, *changeable*; the most enduring, or apparently fixed, being of a description, changeable under severe straining and mechanical violence, which he has denominated *retentive magnetism*.

Only one particular, that he is aware of, in Mr. Smith's exposition, remains at all inaccordant with his (Dr. Scoresby's) conclusions; and that is the retaining, in the case of two iron ships which have been swung at the Cape, of the deviation in its *original direction*. But this fact in so limited an experience can prove little; and even that to which it seems to point,—the existence of an apparent quality of *permanent* magnetism, admits, he believes, of a simple (probable) explanation, namely, that the intense development of retentive magnetism in some heavy masses of upright iron, such as the stern-post, &c., had not encountered sufficient mechanical violence to invert or obliterate their original polarity.

The circumstances under which the greatest magnetic and compass changes might be expected were then noticed. 1. In *new ships* first encountering heavy straining or rolling by the sea. Illustrated case, the 'Tayleur.' 2. In ships generally when first put on a voyage to a very different region. 3. In ships long running on one course and then suddenly changing their direction. Cases of the 'Ripon,' passing Cape Finisterre, other ships passing Cape Bon, and numerous ships rounding the Cape of Good Hope—probably the 'Birkenhead.' 4. In ships proceeding into the southern hemisphere. Cases numerous. 5. Stroke of the sea. Case of the 'Ottawa.' 6. Stroke of lightning. Case of the 'Bold Buccleugh.'

On the other hand, no *large* changes may be expected under these circumstances:—1. In iron ships long in use, and ordinarily pursuing the same voyage within the temperate zone of the northern hemisphere; because the extreme original deviation, as occasioned by the oblique position of the ship's magnetic polar axis, gets shaken down into a medium or *normal* position, out of which it is less liable to be disturbed. 2. Hence in ships trading in our home channels or about our own coasts, or crossing the Atlantic in parallels not very much lower, the liability to new or unexpected changes greatly diminishes. In such cases an intelligent captain observing the changes of deviation in all his progress, outward and homeward, and noting the particular allowances and corrections, will generally be able to run by compass course with considerable confidence.

The suggestions of the author in the way of remedy were:—1. A compass on a pedestal on the quarter or poop deck, in a position of small deviation, and sufficiently high for observing over the bulwarks for amplitudes, bearings of distant land, &c. 2. The avoidance of masses of iron in the immediate vicinity of the steering or other compass. 3. A *reference compass aloft* placed on the mizen mast (or elsewhere), clear of iron chains and iron work, as high as may be requisite for reducing the deviation to an unimportant quantity. This was the plan, and the only one (happily a practical and simple one) the author believes could ever reach the extent of the evil; a plan which he had himself adopted and recommended in a work placed before the public (Voyage of Researches and Discoveries in Greenland) in the year 1823. 4. Care in selection of compasses to have ample directive force. The author's improvements, unfortunately but slightly adopted, *except by the Royal Navy*, had, since the year 1839 or 1840, *trebled* the ordinary power of the compass needle, and rendered its endurance all but permanent. 5. Captains should sedulously avail themselves of opportunities of testing their compasses, and determining the deviations on the courses steered, by azimuths and other modes of observation. 6. Captains should be specially informed and instructed on the leading principles of magnetism influencing the disturbing action of iron ships, and the liability to compass changes. For here, in addition to the ordinary dangers of navigation, is a peculiar source of error and misguidance, respecting which it is most important that the captain should never be thrown off his guard.

In the course of his remarks, Dr. Scoresby said that the circumstances under which the 'Tayleur' had been built, as to the position of her head towards the N.E., and the violent straining and rolling she endured soon after putting to sea, with her head in a direction nearly opposite, or westerly, would fully account, as he believed, on principles he had long maintained and asserted, for the remarkable change in that unfortunate ship's compasses.

On the Inefficiency of the Aids of Science at present in connexion with the Compasses of Iron Ships. By J. T. Towson, *Secretary to the Local Marine Board, Liverpool.*

In the name of the merchants and shipowners of Liverpool, he implored the attention of the Section to this important subject, in the hope and belief that if the members should respond to that appeal, they would be able, before the next Meeting, to confer the benefit they sought, not on their account alone, nor in consideration of the vast amount of property involved, but for the sake of the vast amount of human life which was continually being jeopardized and lost. They made their request in the belief that the compasses of iron vessels, if aided by all the appliances which science at present afforded, and adjusted and managed by the most talented individuals whom owners could engage, were still unworthy of confidence.

Dr. Scoresby had correctly arranged magnets in three classes,—permanent, retentive, and inductive. The term "retentive" ought, in his opinion, to receive the sanction of the Section. The Rev. Doctor had relieved him from a great amount of difficulty in expressing his opinions on the subject. He did not dissent from anything that he had said; but he wished to point out what he believed to be another source of error in connexion with compasses, deserving their serious consideration. He alluded to the change that took place in the inductive magnetism of a ship when she heeled over. In 1846, Mr. Walker, the Queen's Harbour-master at Plymouth, obtained the permission of the Admiralty to examine the compasses of the 'Recruit' when heeling; and the result was, that the error from this cause was found to amount to nearly one-half the maximum error experienced when on an even beam. He believed that many of the errors in compasses on board both wood and iron ships, which neither the mariner nor the compass-adjuster could account for, was to be attributed to "heeling." In the only six cases in which he had been able to obtain information of the heeling of iron ships, it had been shown that considerable errors had arisen from this cause; but these, of course, were not sufficient to establish a theory. He thought, however, that the disastrous loss of the 'Tayleur' might possibly have arisen from this cause. All the tables of deviations of compasses of ships that had heeled had the maximum amount of error, arising from heeling, when the ship's head was directed within two or three points of the magnetic poles, the same being the point of no-deviation when the ship's beam was horizontal. In all cases, the north pole of the compass had been drawn towards the point to which the ship heeled. Besides collateral means adopted for correcting the compass, there were two systems in use for that purpose: Capt. Johnson's system of swinging the ship and tabulating the results, which was exclusively employed in the Royal Navy; and the Astronomer Royal's method of compensating the compasses by means of magnets, which was almost exclusively resorted to in this port. The objection to Capt. Johnson's plan was, that the corrections were liable to be employed the wrong way. His experience in the examination of about 2000 masters of merchant vessels had convinced him of the soundness of that objection. There was a general tendency in practice to come to a wrong conclusion on the subject. The mariner knew that westerly deviations indicated that the north end of the needle was drawn to the west; and came to the conclusion, that if his compass had a westerly deviation, it must cause an object bearing north to appear westerly, whereas it would really appear easterly; and he had known the same mistake made on board ships in the Royal Navy. The most formidable objection to the Astronomer Royal's system was, that the magnetic poles of the compensating magnets were liable to change or to vary in their intensity. Theoretically, this appeared probable; but he had no well-established fact to illustrate it. The change of retentive magnetism, deviation from heeling, and the change produced by going to the other hemisphere, were defects common to both systems. The greatest evil, which in his opinion was connected with magnetic compensation, was that it concealed the amount of original deviation. He had never met with a captain who could tell him the original deviation of his compass if thus corrected. In the case of the 'Tayleur,' the deviation of her steering compass was 60°, of her compass before the mizenmast 40°. Was there ever such a case in the Royal Navy? Lieut. Pasco, when appointed to the 'Jackal' in 1845, was dissatisfied with a deviation of 25°, and obtained permission of the Admiralty to have the compass replaced, when it was reduced to 18°; and no doubt the masters of merchant vessels on this point would be equally prudent if they knew what the real amount of original error was.

GENERAL PHYSICS.

On the Density of various Bodies when subjected to enormous compressing Forces. *By* W. FAIRBAIRN, *C.E., F.R.S.*

The author briefly explained the apparatus which he made use of, and gave a sketch of the results at which he had arrived; but as these were almost entirely given in tables, we are unable to detail them without the aid of these, which are too voluminous for insertion in full. Among other matters of extreme general interest, he stated that, besides these common pressures of 7000 lbs. to the square inch, and 11,000 lbs., such as used in Mr. Hopkins's experiments, he had applied pressures of 0,000 lbs. and 90,000 lbs. to the square inch, or what would be equivalent to the weight of a column of water over 33 miles in height. Under this enormous pressure, clay and some other substances had acquired all the density, consistency, and hardness of some of our hardest and densest rocks.

Nouvelles Expériences sur le Mouvement de la Terre au Moyen du Gyroscope. *By* M. L. FOUCAULT, *Paris.*

The author spoke in French, but very distinctly, and the apparatus was so simple, beautiful, and exquisitely constructed, that the experiments all perfectly succeeded, and fully interpreted the author's meaning as he proceeded. The gyroscope is a massive ring of brass connected with a steel axis by a thinner plate of the same metal, all turned beautifully smooth, and most accurately centred and balanced; in other words, the axis was made to pass accurately through the centre of gravity, and to stand truly perpendicular to the plane of rotation of the entire mass. On this axis was a small but stout pinion, which served, when the instrument was placed firmly on a small frame, containing a train of stout clock-work, turned by a handle like a jack, to give it an exceedingly rapid rotatory motion on its axis. But to this clock-work frame it could be attached, or detached from it instantly. This revolving mass was only about 3 inches wide, and four of them were mounted in frames a little differently. The first was mounted in a ring, attached to a hollow sheath, which only permitted the axle and the pinion to appear on the outside, so that it could be laid hold of, or grasped firmly in the hand, if the pinion were not touched, while the mass inside was rapidly revolving without disturbing that motion. By this modification of the gyroscope, the author afforded to the audience a sensible proof of the determination with which a revolving mass endeavours to maintain its own axis of permanent stable rotation; for upon setting it into rapid rotatory motion, and handing it round the room, each person that held it found himself forcibly resisted in any attempt to turn it round either in his fingers, to the right hand or left, or up or down, or in his hands if he swung it round; so that the idea was irresistibly suggested to the mind, that there was something living within which had a will of its own, and which always opposed your will to change its position. The second modification presented the mass suspended in a stout ring, which was furnished with projecting axles, like the ring of the gimbal. These axles could be placed in a small frame of wood bushed with brass. This small frame, when placed on a piece of smooth board, could be turned freely round by turning the piece of board on which it rested as long as the gyroscope was not revolving, friction being sufficient to cause the one to turn with the other; but, when the gyroscope was set rapidly revolving, in vain you attempted to turn the frame, by turning the board on which it rested, so determinately did it endeavour to maintain its own plane of rotation, as quite to overpower the friction. In the third modification of the gyroscope it was suspended in gimbals, so exquisitely constructed that both the gyroscope proper and the supporting gimbals were accurately balanced, so as to rest freely when placed in any position in relation to the earth. By this the author showed most strikingly the effect of any attempt to communicate revolving motion round any other axis to a mass already revolving, for, on placing the gimbals in a frame of wood while the gyroscope was not revolving, it remained quite steady; but, when thrown into rapid revolving motion, the slightest attempt to turn the frame round to the right or to the left was instantly followed by the entire gyroscope turning round in the gimbals, so as to bring its axis to coincide with the new axis you endeavoured to give it, with a life-like precision, and always so as to make its own direction of revolution be the same as that of the slightest turn you impart to it. Having thus demonstrated the necessary effect of combining one rotatory motion with another, he then proceeded to demonstrate palpably that the earth's revolving motion affected the gyroscope in precisely a similar way. Having, by the screw adjustments, brought the gyroscope, in gimbals, to a very exact balance, it remained fixed in any position when not revolving. But, rapid rotatory motion having been communicated to the gyroscope mass as soon as the gimbal supports are placed on the stand, you see the entire apparatus, slowly at first, but at length more rapidly, turn itself round, nor ever settle until the axis, on which the gyroscope is revolving, arranges itself parallel to the terrestrial axis, in such a sense as to make the direction of the revolving gyroscope to be the same as that of the whole earth. He next showed that the determination with which it did this was sufficient to control the entire weight of the instrument, though that amounted to several pounds; for, taking the ring gyroscope, from the side of the ring of which a small steel wire projected, ending in a hook, the wire coincided with the prolongation of the axis of the gyroscope: of course, when not made to revolve, the hook, if placed in a little agate cup at the top of a stand, would permit the instrument, by its weight, to fall instantly, as soon as the support of the hand was taken from it. But, upon imparting to it rapid rotatory motion, it stood up even beyond the horizontal position, so as to bring its axis of rotation nearly to the same inclination to the horizon as the axis of the earth, while the whole acquired a slow rotatory motion round the point of the hook; and so steady was its equilibrium while moving thus, that a string being passed under the hook and both ends brought together in the hand, the whole might be lifted by the cord off the stand and carried revolving steadily about the room. Next, to show the motion of the earth sensibly, he placed the gimbal gyroscope suspended freely by a fine silk fibre in a stand with the lower steel point of its support resting in an agate cup; a long light pointer projecting from the ring carried a pointed card which passed over a graduated card arch of a circle placed concentrically with the gyroscope; upon imparting rapid rotatory motion to the gyroscope the index was seen as the earth moved to point out the relative motion of the plane of rotation exactly in the same way; the law of the motion being also the same as that of the well-known pendulum experiment. Lastly, he set the ring gyroscope in motion, and by placing a small pointed piece of brass at the end of the axle on the ring, the instrument went immediately through all the evolutions of a boy's top on the floor, humming meanwhile loudly also.

An Account of some Experiments on the Effect of Pressure on the Temperature of Fusion of different Substances. By W. Hopkins, *M.A., F.R.S.*

Before proceeding to give an account of these experiments, Mr. Hopkins stated his great obligations to Mr. Fairbairn for the promptitude with which, in the first instance, he proffered his assistance and cooperation, and the manner in which he had since afforded the aid of his great practical knowledge and the ample means which his establishment affords for conducting experiments of this nature. He expressed also his great obligations to Mr. Joule. He then proceeded to describe the apparatus which had been used and the causes of the successive failures, till, by degrees, apparatus had been devised and constructed which was likely to prove entirely successful for all substances sufficiently fusible to be experimented on. One difficulty had been in ascertaining the moment when the substance enclosed, as it was, in a metal tube, became fluid, but it had been overcome by the following process. A small portion of the substance was put into a brass tube open at one end, and of about a quarter of an inch in diameter, and was then melted. In this state, one end of a magnetized needle was inserted in it to the depth of about half an inch, after which the substance was left to cool and solidify, the needle thus becoming firmly fixed in it. The tube was then screwed on to the extremity of another tube communicating with a vertical cylinder filled with oil, the tube containing the substance experimented on, and the magnetized needle being also vertical, having the substance at its upper end within the needle projecting downwards from it. This tube was also surrounded by a *bath* filled with oil, the surface of which just covered the upper end of the tube. A powerful lever acted on a piston carefully *packed* and fitting accurately into the vertical cylinder just mentioned, and the pressure thus applied to the oil, filling the cylinder and the tubes, was communicated to the substance at the upper end of the vertical tube. The substance was then gradually and slowly heated by heating the oil in the bath, the temperature of which was known by a thermometer with its ball immersed in it. The temperature was thus increased till the *needle dropped down* from the top of the tube. To ascertain the exact instant when this took place, a small compass was so placed near the top of the tube containing the magnetized needle, that the needle of the compass was deflected about 90° from its natural position, its return to which was the signal that the magnetized needle had fallen, and the substance melted. The temperature of the bath at that instant gave the temperature of liquefaction.

The following are some of the results obtained:—

Substances experimented upon.	Pressure in lbs. to the square inch.			Temperature Fahr. at which it liquefied.		
Spermaceti…………	0	7790	11,880	124°	140°	176°·5
Wax ………………	0	7790	11,880	148·5	166·5	176·5
Sulphur ……………	0	7790	11,880	255	275·5	285
Stearine ……………	0	7790	11,880	138	155	165

Of course when the weight 0 was on the piston, the substance was under atmospheric pressure, or about 15 lbs. to the square inch; the pressure of 7790 lbs. per square inch was that at which the Britannia Bridge had been raised. Mr. Hopkins had also tried the metallic alloys which fuse at low temperatures, but had not detected any elevation of fusing temperature required by increasing the pressure; but these experiments required to be repeated and confirmed before they could be relied upon.

On Formulæ for the Maximum Pressure and Latent Heat of Vapours. By WILLIAM JOHN MACQUORN RANKINE, *C.E., F.R.SS. Lond. & Edinb., &c.*

The author, reasoning from the supposition that the pressure exerted by a liquid or solid, and its vapour, when in contact with each other, is the result of an expansive elasticity in the vapour, balanced by an attractive force which tends to condense it on the surface of the liquid or solid, many years since arrived at the conclusion that the law connecting the maximum pressure of a vapour with the temperature would probably be found to be represented to a near approximation by the following formula:—

$$\log P = A - \frac{B}{\tau} - \frac{C}{\tau^2} - \&c.;$$

in which τ denotes the temperature measured from the absolute zero of the perfect gas thermometer; P the maximum pressure; and A, B, C, &c., constants to be determined from experimental data for each substance.

The most probable position of the absolute zero of the perfect gas thermometer is—

274° Centigrade=493°·2 Fahr.

below the temperature of melting ice, so that ordinary temperatures are reduced to absolute temperatures by adding

274° for the Centigrade scale,
461°·2 for Fahrenheit's scale.

Having applied this formula to M. Regnault's experiments on the pressure of steam, using three terms only, with three constants A, B, C, determined from three experimental data, he found the results of experiment and calculation to correspond closely throughout the whole extent of the experiments. The same was the case with M. Regnault's experiments on the vapour of mercury, using a formula of two terms only.

Formulæ of three terms for alcohol and æther, and of two terms for turpentine and petroleum, were found to represent the results of Dr. Ure's experiments on these fluids as closely as could be expected from the degree of precision of the experiments.

These investigations were published in the 'Edinburgh New Philosophical Journal' for July 1849.

M. Regnault having recently published an extensive series of experiments on the pressures of the vapours of æther, sulphuret of carbon, alcohol, essence of turpentine, and chloroform (Comptes Rendus, 14th August 1854), the author has applied formulæ of the kind proposed by him, of three terms, to these experiments; and the present paper states the results of these investigations, and gives a table of the constants in the formulæ for the pressures of the vapours of the five fluids above named, together with those for water and mercury, formerly determined. The constants for water and mercury are slightly modified to adapt them to the position of the absolute zero now considered most probable, that formerly adopted by the author having been 0·6 of a Centigrade degree lower; but this modification causes no practically appreciable alteration in the computed pressures*.

The degree of closeness of the agreement of the formulæ with the results of experiment, corresponds in a remarkable manner with the degree of purity in which, according to M. Regnault, the fluids can be obtained. For sulphuret of carbon, which is easily obtained pure, the agreement is nearly as close as for steam; for æther, somewhat less close, but still satisfactory; for alcohol, the formula is not applicable with certainty below 0° Cent.=32° Fahr., but is about as precise as that for æther above that temperature; for essence of turpentine (which undergoes a molecular change by boiling), the formula is not applicable below 40° Centigrade, and for chloroform (which it is impossible to obtain absolutely pure), not below 70° Centigrade; but above these temperatures the agreement is very satisfactory.

The author shows that, although the densities of the vapours of the seven fluids referred to are known only by conjecture, the formulæ for their maximum pressures afford the means of computing for each fluid the function $\tau \frac{dP}{d\tau}$, being the mechanical equivalent of the latent heat of evaporation at any given temperature of so much of the fluid as is necessary to fill, in the state of vapour, a space greater than it fills in the liquid state by unity of volume†.

On Mechanical Antecedents of Motion, Heat, and Light.

By Professor W. Thomson, *M.A., F.R.S.*

This communication was opened with some general explanations regarding mechanical energy, and the terms which have been introduced to designate the various forms under which it is manifested. Any piece of matter, or any group of bodies, however connected, which either is in motion, or can get into motion without external assistance, has what is called mechanical energy. The energy of motion may be called either "dynamical energy" or "actual energy." The energy of a material system at rest, in virtue of which it can get into motion, is called "potential energy." The author showed the use of these terms, explained the idea of a *store of energy*, and conversions and transformations of energy, by various illustrations. A stone at a height, or an elevated reservoir of water, has potential energy. If the stone be let fall, its potential energy is converted into actual energy during its descent, exists entirely as the actual energy of its own motion at the instant before it strikes, and is transformed into heat at the moment of coming to rest on the ground. If the water flow down by a gradual natural channel, its potential energy is gradually converted into heat by fluid friction, according to an admirable discovery made by Mr. Joule of Manchester above twelve years ago, which has led to the greatest reform that physical science has experienced since the days of Newton. From that discovery, it may be concluded with certainty that heat is not matter, but some kind of motion among the particles of matter; a conclusion established, it is true, by Sir Humphrey Davy and Count Rumford at the end of last century, but ignored by even the highest scientific men during a period of more than forty years. Mr. Joule, by a series of well-planned and executed experiments, ascertained that a pound of water would have its temperature increased by 1° (Fahrenheit) if it kept all the heat that would be generated by its descent through 772 feet; that is, the "actual" or "dynamical" energy of as much heat as raises the temperature of a pound of water 1° is an exact equivalent for the potential energy of a pound of matter 772 feet above the ground. Mr. Joule also fully established the relations of equivalence among the energies of chemical affinity, of heat, of combination, or of combustion, of electrical currents in the galvanic battery, of electrical currents in magneto-electric machines, of engines worked by galvanism, and of all the varied and interchangeable manifestations of calorific action and mechanical force which accompany them. These researches, with the theory of animal heat and motion in relation to the heat of combustion of the food, and the theory of the phænomena presented by shooting stars, due to the same penetrating investigation, have afforded to the author of the present communication the chief groundwork for his speculations.

---

* A table of these constants is published in the Philosophical Magazine for December 1854.

† This principle has been successfully applied to the computation of the densities of vapours from their latent heats of evaporation, in a paper read to the Royal Society of Edinburgh, February 19th, 1855.

The heat emitted by animals, and the mechanical effects which they produce, are transformations of the energy of chemical affinity with which the food consumed by them combines with the oxygen they inhale. The heat, sound, and mechanical effects produced by the explosion of gunpowder are, all together, equivalent to the energy of chemical affinity between the different substances of which gunpowder is composed. The potential energy of war is contained in the stores of gunpowder and food brought into the field. The gunpowder carried by artillery and infantry contains all the potential energy ordinarily brought into action by those two arms of the service. The men's food, and the forage for the horses, contain the stores of potential energy drawn upon in a charge of cavalry. Artillerymen, foot soldiers, sailors, steamers with their engines, guns, swords, are only means and appliances by which the potential energy contained in the stores of gunpowder and food is directed to strike the blows by which the desired effects are produced.

The heat and mechanical actions of animals are transformations of the potential energy of their food mechanically equivalent to the heat that would be got by burning it. The food of animals is either vegetable, or animal fed on vegetable, or ultimately vegetable after several removes. Now, except mushrooms and other funguses, all of which can grow in the dark, are nourished by organic food like animals, and absorb oxygen and exhale carbonic acid like animals, all known vegetables get the greater part of their substance, certainly all their combustible matter, from the decomposition of carbonic acid and water, absorbed by them from the air and soil. The separation of carbon and of hydrogen from oxygen in these decompositions is an energetic effect, equivalent to the heat of recombination of those elements by combustion or otherwise. The beautiful discovery of Priestley, and the subsequent researches of Sennebier, De Saussure, Sir Humphrey Davy, and others, have made it quite certain that those decompositions of water and carbonic acid only take place naturally in the day time, and that light falling on the green leaves, either from the sun or from an artificial source, is an essential condition, without which they are never effected. There cannot be a doubt but that it is the dynamical energy of the luminiferous vibrations which is here efficient in forcing the particles of carbon and hydrogen away from those of oxygen, towards which they are attracted with such powerful affinities; and that luminiferous motions are reduced to rest, to an extent exactly equivalent to the potential energy thus called into being. Whether or not the coolness of green fields and fresh foliage is to any sensible extent due to this cause, it is quite certain that sun-heat is put out of existence as heat, in the growth of plants in any locality, and that just as much heat, neither more nor less, is emitted from fires in which the whole growth of any period of time is burned. Coal, composed as it is of the relics of ancient vegetation, derived its potential energy from the light of distant ages. Wood fires then give us heat and light which has been got from the sun a few years ago. Our coal fires and gas lamps bring out for our present comfort heat and light of a primeval sun which have lain dormant as potential energy beneath seas and mountains for countless ages.

We must look then to the sun as the source from which the mechanical energy of all the motions and heat of living creatures, and all the motion, heat, and light derived from fires and artificial flames is supplied. The natural motions of air and water derive their energy partly, no doubt, from the sun's heat, but partly also from the earth's rotary motion and the relative motions and mutual forces between the earth, moon, and sun. If we except the heat derivable from the combustion of native sulphur, and of meteoric iron, every kind of motion (heat and light included) that takes place naturally, or that can be called into existence through man's directing powers on this earth, derives its mechanical energy either from the sun's heat or from motions and forces among bodies of the solar system.

In a speculation recently communicated to the Royal Society of Edinburgh, the author has shown that the sun's heat is probably due to friction in the atmosphere between his surface and a vortex of vapours, fed externally by the evaporation of small planets, in a region of very high temperature round the sun, which they reach by gradual spiral paths, and falling in torrents of meteoric rain, down from the luminous atmosphere of intense resistance, to the sun's surface.

A continuation of the inquiry raises the question, from what source do the planets, large and small, derive the mechanical energy of their motions? This is a question, to the answering of which mechanical reasoning may legitimately be applied: for we know that from age to age the potential energy of the mutual gravitation of those bodies is gradually expended, half in augmenting their motions, and half in generating heat; and we may trace this kind of action either backwards or forwards; backwards for a million of million of years with as little presumption as forwards for a single day. If we trace them forwards, we find that the end of this world as a habitation for man, or for any living creature or plant at present existing in it, is *mechanically inevitable;* and if we trace them backwards according to the laws of matter and motion, certainly fulfilled in all the actions of nature which we have been allowed to observe, we find that a time must have been when the earth, with no sun to illuminate it, the other bodies known to us as planets, and the countless smaller planetary masses at present seen as the zodiacal light, must have been indefinitely remote from one another and from all other solids in space. All such conclusions are subject to limitations, as we do not know at what moment a creation of matter or energy may have given a beginning, beyond which mechanical speculations cannot lead us. If in purely mechanical science we are ever liable to forget this limitation, we ought to be reminded of it by considering that purely mechanical reasoning shows a time when the earth must have been tenantless; and teaches us that our own bodies, as well as all living plants and animals, and all fossil organic remains, are organized forms of matter to which science can point no antecedent except the Will of a Creator, a truth amply confirmed by the evidence of geological history. But if duly impressed with this limitation to the certainty of all speculations regarding the future and pre-historical periods of the past, we may legitimately push them into endless futurity, and we can be stopped by no barrier of past time, without ascertaining at some finite epoch a state of matter derivable from no antecedent by natural laws. Although we can conceive of such a state of all matter, or of the matter within any limited space, and have cases of it in the arbitrary distributions of temperature, prescribed as "initial" in the theory of the conduction of heat (see* Cambridge Mathematical Journal, vol. iv. 1843), yet we have no indications whatever of natural instances of it, and in the present state of science we may look for mechanical antecedents to every natural state of matter which we either know or can conceive at any past epoch however remote.

It is by tracing backwards the motions which are at present observed, according to the known laws of motion and heat, with no limit as to time, that the author arrives at the conclusion that the bodies now constituting our solar system have been at infinitely greater distances from one another in space than they are now. He remarked that the nebular theory, as ordinarily stated, assuming as it does a previously gaseous state of matter, is not only untrue, but the reverse of the truth, according to the views now brought forward, since these show evaporation as a necessary consequence of heat generated by collisions and friction, and the general past and present tendency of matter is seen to be the conglomeration of solids and liquids accompanied by a gradual increase of the quantity of gaseous fluid occupying space.

---

* "Note on some points in the Theory of Heat," a short article in which it was shown how to test the age of a distribution of heat, by applying a certain criterion of convergence to its expression in the infinite series characteristic of the external circumstances of the body in which it is given.

Prof. Helmholtz, in a most interesting popular lecture on transformations of natural forces, delivered on the 7th of February last at Königsberg, has estimated that, if the particles at present constituting the sun's mass have been drawn together by mutual gravitation, from a state of infinite diffusion, as supposed in the nebular theory, not however a gaseous state, as ordinarily supposed, but a state in which the particles exercise no mutual action except that of gravitation, the whole heat generated must have amounted to about 28,000,000 thermal units Centigrade per pound of the sun's mass. This estimate would not, as the author of the present paper shows, require any change, whether we assume, as the antecedent condition of the solar mass, a state of infinite diffusion, or a state of aggregation in solid masses of any dimensions small compared with his present dimensions, and separated from one another at comparatively great distances; provided always there has been no relative motion among them except what is generated by mutual gravitation. If, then, the whole mass of the sun has grown by the process which, according to the author's theory of solar heat (*certain* as regards a part, whether or not it may be sufficient to account for the whole of the radiation of solar heat), we know to be augmenting it at present, there must have been generated, in the whole process of conglomeration, the quantity of heat stated above; a quantity which amounts to about 20,000,000 times as much as is at present radiated off in one year. The author gave reasons for believing that this heat must have been nearly all radiated off immediately on being generated, and that enough of it has not been retained in the conglomerated mass to be the store from which the heat at present radiated is drawn.

That the present solar radiation is supplied chiefly from a store of heat contained in the mass, whether created there or generated mechanically by the impact of meteors which have fallen in during remote periods of past time, appears very improbable.

On the contrary, there must in all probability be some agency continually supplying heat to compensate the loss constantly experienced by radiation from the sun; and that agency*, as the author has shown elsewhere, can be no other than the mechanical action of masses coming from a state of very rapid motion round the sun to rest on his surface.

The author showed how a system of solid bodies, large and small, initially at rest and at great distances from one another, may, by their mutual gravitations, and by the resistance their motions must experience in the gaseous atmosphere, evaporated from them by the heat of their collisions after a vast period of time, come into a state of motion, heat, and light, analogous to the present condition of our solar system and the stars. The origin of rotatory motion is explained by showing that different systems starting from rest will influence one another so as to acquire contrary rotatory motions, without any aggregate of rotatory momentum being acquired by the whole. Any system or group beginning to concentrate round one principal mass, after having thus acquired a momentum of rotatory motion, will acquire from it, in a certain stage of advancement, just such approximately circular motions as those of the planets, the particles of the zodiacal light and the satellites of our solar system, and such rotatory motions as the central and other masses are known to have, all chiefly in one direction.

---

* It is quite certain that it cannot, as the nebular theory has led some to suppose it may, be the energy of gravitation effecting any continued condensation of the sun's present mass, since without increased pressure, it is only by cooling that any condensation can be taking place; and the heat emitted in consequence of condensation by cooling, would depend merely on the specific heat of the whole mass in its actual circumstances of temperature and pressure, and might (for all we know of the properties of matter at such high temperature and pressures) be greater than, equal to, or less than the thermal equivalent of the work done by gravity on the contracting body.

In considering the question whether all the heat and motion existing in matter have their origin in that action by which their amount is at present being increased, it is shown that, unless their entire actual energy exceeds a certain definite limit, namely, the value of the whole potential energy of gravitation that would be spent in drawing all the particles of matter from a state of infinite diffusion into their present positions, it is quite possible they may be so produced; or that *the potential energy of gravitation may be in reality the ultimate created antecedent of all the motion, heat, and light at present in the universe.*

On the Motion of Fluids; a remarkable variation in the great Elementary Law of the ratio between Pressure and Velocity. By WILLIAM PETRIE, *Woolwich.*

One of the most universally recognised laws of the flow of fluids is, that the velocity of flow through an aperture from or to a containing vessel varies as the square root of the pressure, and this law is evidently a necessary corollary from the first principles of dynamics.

The present paper is to call attention to the fact, that when the passage through which the fluid (as air or water) is forced, consists of a *single check*, such as a *simple hole*, the above law holds precisely true; yet when the passage consists of an indefinitely numerous consecutive *series of checks*, such as a tube containing sand, the velocity of flow varies in the *direct arithmetical ratio* of the pressure; and that in the intermediate cases of a *few* consecutive checks being placed to retard the flow of the fluid, the law seems to follow various intermediate ratios accordingly. For the case of about 30 consecutive checks causes the law of variation of velocity to be as the ¾ power of the pressure.

Whether this important law be altogether new or not, the author feels it to be most perplexing; it being, apparently, contrary to the most indubitable deductions from the above-named great elementary law. For it is to be observed that it is no question regarding the *absolute* velocity of flow through the checking passage, under a certain pressure of fluid; *that* might well be regarded as incalculable, and not accurately amenable to any discoverable rules in such a practically complex dynamical condition as the flow of air or of a liquid through a mass of sand. But the question regards the effect of a simple *variation of pressure, cæteris paribus*, in which variation, therefore, all the directions and counteractions of currents, however complex, must remain relatively precisely the same, the velocities of all being necessarily affected in precisely the same ratio. The subject has many ramifications which the author hopes in some degree to follow up.

On a Method of Computing the Absolute Volume of the Ultimate Particles of Liquids. By J. J. WATERSTEN.

In this paper certain theoretical views regarding the mutual action of particles of a liquid, especially near its free surface, were brought forward, according to which a relation between the latent heat of its vapour and the contractile tendency of its surface was established in terms of the dimensions of its atoms, supposed by the author to be finite. Experiments on the forms and dimensions of drops of water, and the bearing of water in capillary tubes, exhibited by diagrams traced from photographs, were described, from which the capillary tension of a free surface of water was estimated. A comparison of this result with data regarding the mechanical action of steam afforded by M. Regnault and Mr. Joule by experiment, led the author to the conclusion that the number of atoms in a cubic inch of water is about equal to the cube of 216,000,000; or, that there are only as many atoms of water in a mass of the liquid equal in volume to a billiard ball, as there are of such volumes in the whole bulk of the earth.

A relation between the capillary tensions of different liquids, their atomic weights, and the latent heats of their vapours, was shown to follow from the theory; and it was pointed out that, as far as experiment gives data for judging, this relation appears to be fulfilled in the comparative conditions of water and alcohol.

CHEMISTRY.

On the Constitution of Meconine and Papaverine, and their Relations to the other Constituents of Opium. By THOMAS ANDERSON, *M.D., Professor of Chemistry in the University of Glasgow.*

The author commenced by referring to the opinion often expressed by chemists, that where several well-marked crystalline compounds are met with in the same plant, some definite chemical relation must exist between them. But even in those cases—as for instance in that of quinine and cinchonine, where the formulæ of the substances are very simply related—the conversion of one into the other has not been successful. In the course of the author's investigation of the opium compounds, he had obtained a product of decomposition of narcotine, which he called opianyle. The result of the experiments now detailed showed that this substance is identical with the meconine which Combe found naturally existing in opium. The author having thus made the first step towards the simplification of the complex chemistry of opium, concluded by pointing out the relations subsisting among its other constituents; and expressed the opinion that these could not be fortuitous, but pointed to the possibility of further simplifications.

On the Alkaloids produced during the Destructive Distillation of Animal Substances. By THOMAS ANDERSON, *M.D., Professor of Chemistry in the University of Glasgow.*

This paper contained the details of Dr. Anderson's most recent researches on the volatile basis of Dippel's oil. He gave a description of a new base, collidine, belonging to the picoline series, and a set of experiments which established the fact that these substances belong to the class of nitryle bases. Ethylo-piridine and ethylo-picoline were described, and their decompositions explained.

On Collodion Negatives. By GEORGE ROBERT BERRY, *Liverpool.*

There appears to have been a great difficulty with many operators in obtaining that requisite intensity of negative collodion proof that shall by the after-printing yield satisfactory positive paper impressions. Selecting from the formulæ generally followed, the author of this paper applied chloride of gold to the negatives he desired to strengthen, in the proportion of one grain to an ounce of water; and if this did not produce the desired result, he, after washing away the excess of chloride, floated over the proof a solution of sulphide of ammonium, varying in strength from 3 to 40 drops to 1 oz. of water. By this means, impressions so feeble as to be hardly visible by transmitted light became capable of yielding satisfactory results when used for printing. One difficulty remained:—the collodion film, at all times tender while moist, becomes so easily disrupted from the glass plate after the application of any of the strengthening processes, that the acquisition of a perfect negative was the exception and not the rule. This obstacle may be easily surmounted by allowing the photograph to dry after being developed and fixed either by cyanide of potassium or hyposulphite of soda, and then varnishing in the usual way. The photograph may then at any period of time be safely strengthened by repeating the gold and sulphide of ammonium process, observing to use rectified spirit of wine instead of water as the menstruum for the gold and sulphide. The tenacity of the varnish ensures the safety of the collodion film, and another coat of varnish completes the process. The author found that by the use of gallic acid in his silver bath the time of exposure was much prolonged in the camera, but the developed pictures proved of extraordinary intensity, and by this means he has at all times been able to produce satisfactory negatives, provided always that the collodions employed be not made sensitive by iodide or bromide of ammonium. It is true that a portion of gallate of silver soon precipitates, but silver solutions of moderate strength always retain in solution a portion of the precipitant; and this fact has been made use of by the author, Mr. Thomas and some others, by adding excess of moist iodide of silver to a new silver bath, to obviate the tendency it has to dissolve out the film of iodide of silver on the collodion plate. When using a bromide as the sensitizing agent, bromide of calcium has been found most effective; the nitrate of lime resulting from its decomposition in the silver bath having no detrimental action. The formula is as follows:—bromide of calcium, 4 grains; dissolve in spirit of wine 2 drachms; add rectified æther 6 drachms, gun cotton *quan. suff.* The silver bath used must be 60 grains to the ounce. The bromized collodion is tolerably rapid, and, unlike most others, improves by age, even beyond a twelvemonth. The author has used the following formula with a simple 30-grain silver bath, and has obtained in all the varying conditions of light, whether of views or portraits, any amount of vigour desired:—The collodion: Take pure iodide of potassium, any quantity; triturate this in a glass mortar with spirit of wine, 54 over proof, until the spirit is unable to dissolve more of the iodide. Take of this solution 3 parts; sulphuric æther, free from acid, 5 parts; mix and dissolve in it gun cotton, to form a tough and rather thick film. The developing agent is, pyro-gallic acid, 2 grains; glacial acetic acid, 20 drops; spirit of wine, 1 drachm; water to make up 1 oz.

On the Physiological Properties of Carbazotic Acid. *By* Professor F. Crace Calvert.

The author stated that he had supplied some of this acid to Dr. Bell, Physician to the Royal Infirmary, Manchester, who had cured several cases of intermittent fever with it. He also said that he should be very happy to furnish any physician with a small quantity of this substance, so that its real medical value might be ascertained. After describing the process by which pure carbazotic could be procured from carbolic acid, he impressed upon the Meeting the value of the pure acid as a yellow dye for silk.

On the Action of Gallic and Tannic Acids on Iron and Alumina Mordants. *By* Professor F. Crace Calvert.

The author drew the following conclusions from the facts contained in his communication:—1st. That there can be no doubt that tannic acid is the matter in tanning substances which produces black with iron mordants. 2ndly. That the reason of gallic acid producing no black dye is, that it reduces the peroxide of iron in the mordant, forming a colourless and soluble gallate of protoxide of iron. 3rdly. That gallic acid has the property of dissolving hydrate of alumina, and also of separating alumina mordants from the cloth on which they are fixed. 4thly. That the reason of extracts of tanning matter losing their dyeing properties is, that the tannin is transformed into gallic acid. 5thly. That gallic acid possesses the property of dissolving iron, and thus lays claim to the character of a true acid; whilst tannin, not having this action, appears to him to be in reality a neutral substance. 6thly. He also found that 2 to 39° of impure carbolic acid added to extracts of tanning matters, such as those of sumach, quercitron bark, &c., completely prevented for several months the transformation of the tannin which they contained into gallic acid, and thus rendered tannin extracts commercially useful.

On the Action of Citric, Tartaric and Oxalic Acids on Cotton and Flax Fibres under the influence of Dry Heat and Pressure of Steam. *By* Professor F. Crace Calvert.

Mr. Calvert has observed that when two to four parts of these acids are dissolved in 100 parts of water, and linen or cotton dipped into the solution obtained, and afterwards dried in the air, they, on exposure to certain temperatures, completely destroy the tenacity of the fibre. This action of organic acids is interesting when it is known

that it takes place even at the low temperature of 180°, 212° and 260° Fahr. He also found that cotton and flax fibres, when prepared as above and then submitted to the influence of steam of three lbs. pressure, were destroyed.

On the apparently Mechanical Action accompanying Electric Transfer. *By* ANDREW CROSSE.

The author found, by electrifying a sovereign positively in close contact with a piece of carbonate of lime, under nitric acid diluted with fifty times its quantity of water, that a portion of the milled edge of the coin was struck off in pieces, some of which were large enough to retain the milled edge upon them distinctly. The voltaic action was kept up for fifty hours; and at the expiration of that time the coin had lost three grains in weight; and a ground glass rod that used to keep the coin in contact with the limestone was permanently gilded; and this took place at the positive pole. The weight of the portions removed from the coin exactly corresponded with the deficiency. The solution being tested contained nitrate of lime, but no gold nor copper. He likewise found, on repeating this experiment with sulphuric acid, similarly diluted—the voltaic action being kept up for ninety hours—that six grains of gold were removed from the edge of the coin; and the pieces broken off weighed the same, A strip of glass being placed on the edges of the jar containing the dilute acid, and half an inch above its surface, and in a line with the electric current, had its lower part covered with crystals of sulphate of lime, each one of which was at right angles to the electric current. The friction of the carbonic acid gas, liberated from that part of the limestone in contact with the coin, was apparently the mechanical cause of the removal of the edges. The author stated that he had tried various experiments both with frictional and voltaic electricity upon different substances, which in his opinion proved the effects of the mechanical action accompanying electric transfer.

On the Decomposition of Magnesian Limestone at Brodsworth. *By* J. A. DAVIES.

On Collodion Photographs of the Moon's Surface. *By* DR. EDWARDS.

About the commencement of the present year, the Liverpool Photographic Society, recognizing the importance of this object, and the interest felt in it by the British Association at its last meeting, requested Mr. J. A. Forrest, its Secretary, Mr. J. Hartnup of the Liverpool Observatory, and the author, to act as a committee for obtaining photographs of the moon by the Liverpool telescope, and to lay them before the present meeting of the Association. This Committee have produced a large number of pictures with variable success, and some of the most perfect copies are now presented to the meeting. The telescope is furnished with an excellent equatorial mounting, and clock-work motion of great firmness and steadiness. The object glass has a focal length of about 12½ feet, and a small camera-box being substituted for the eyepiece, the image was received upon the ground glass, or prepared plate, in the ordinary manner. After much fruitless labour, the chemical focus was discovered to be about eight-tenths of an inch beyond that of the visual one, the glass being overcorrected to that extent in respect to its actinic focus. This we have since found to be nearly coincident (when the length of foci in the several lenses is duly allowed for) with the experience of Professor Phillips and other labourers in the same field. The focus once accurately ascertained, of course answers for all subsequent experiments. It was at first difficult to decide whether the want of sharpness of outline observed was due to the motion of the object or to imperfect focusing, and the most excellent specimens have been obtained by the continual motion of Mr. Hartnup's steady hand in addition to the clock movement, while his eye was kept on the finder with a micrometic eyepiece of good power, by which he could maintain the position of a given point in the field, without perceptible variation. And, indeed, when the moon is off the meridian, her rate being variable, the above seems the only mode of following her motion accurately.

The author described the chemicals used.

These pictures have been since copied and enlarged in the camera by transmitted light; and, for this purpose, those developed with the iron have been preferred. The excellence of the pictures for transmitted light, whether in copying or illuminating by the lantern, seems to be governed by their tone of colour rather than their apparent opacity. Mr. M'Innes has been very successful in copying and enlarging these pictures for the lantern.

On Photographs upon Albumen. *By* M. Ferrière. *Communicated by the* Abbé Moigno.

During the reading of this paper a number of very large and beautiful photographic drawings were exhibited, as illustrative of the excellence of the process followed.

On the Chemical Examination of some Alloys of Copper and Zinc.

By David Forbes, *F.G.S.*, *A.I.C.E.*

The alloys which formed the subject of this paper were produced accidentally in the ordinary process of brass-making; where, by some accidental circumstances which were difficult to explain, a separation of the compounds contained in an ordinary brass had resulted, and on breaking presented parts of a brilliant silvery white fracture; whereas other parts of the same mass were deep yellow, and of a crystalline texture. Both these were submitted to chemical examination, and the results, as well as the methods of examination, given in detail. The white alloy, which was so brittle as to be easily reduced to powder, was found to consist of copper 46·51, and zinc 53·49 per cent., which would closely approximate to the chemical formula $Cu_7\ Zn_8$. The yellow, which, on the contrary, was not at all brittle, was found to contain 56·91 per cent. copper and 43·09 zinc, or agreeing with the formula $Cu_4\ Zn_3$; so that both these alloys were evidently definite compounds. Specimens were then shown of similar alloys reproduced by the admixture of these metals; and particular attention was drawn to the fact, that a white alloy containing as much copper as 46½ per cent. had not previously been made known; and that above and below this percentage, within very small limits, the alloys were invariably described as yellow; and that in Mallett's researches all alloys mentioned by him containing from as little copper as 32·8 per cent. and upwards, were found to be of a decided, or even dark yellow colour. The peculiarity of the extraordinary brilliant silvery appearance of the white alloy would appear to make it very applicable to the manufacture of reflectors or specula; but no experiments had been made on this point.

On the Occurrence and Chemical Composition of some Minerals from the South of Norway. *By* David Forbes, *F.G.S.*, *A.I.C.E.*

The author commenced by observations on the mode of occurrence of various minerals in the granitic and syenitic rocks of the south-west coast of Norway, and on the frequent appearance of hydrous minerals in rocks which are generally regarded as of igneous origin. He then proceeded to state some general facts observed by him as connected with the development of these minerals, and on several peculiarities of structure apparently induced by them in the rocks in which they were imbedded, dwelling particularly on the special relation which the mineralogical constituents of the rocks, as quartz, felspar, and mica, appear to bear to the development of the minerals themselves: thus it was found that the mica appeared to exercise a very determinate action, as was also the case, though in a less degree, with some particular varieties of quartz; whilst in nearly all cases a discoloured or apparently decomposed appearance of these substances appeared at the point of contact and surrounding the crystals themselves.

Remarks were then made as to a peculiar radial structure developed in the matrix, and immediately around many minerals, as orthite, tachyaphaltite, thorite, &c., and again in other cases as with katap-etite, melanophane, astrophyllite, &c., a radial structure in the arrangement of the crystalline minerals themselves was observed, although in these cases no corresponding radial structure of the matrix was found to exist. After having entered into this subject at some length and drawn the attention of the section to these points of what may be termed "Geological Mineralogy," the study of which was insisted upon as of great importance in elucidating the formation of minerals in nature, the author proceeded to the chemical examination of the minerals, specimens of which were shown, and the results as well as the methods of chemical analysis employed in the examination of several of these minerals were detailed.

Several new minerals were shown, which had been examined and named, and which were found to contain some of the rarer metals and earths, and the properties of these bodies somewhat commented upon.

On the Heating Effects of Secondary Currents. By J. P. GASSIOT, *F.R.S.*

In January last Mr. Gassiot communicated to the editor of the Philosophical Magazine an account of experiments made with Ruhmkorff's induction coil, and alluded to the fact, that the heating effect, which had already been noticed by Masson, took place in the contrary direction to that which is produced in the primary current, which heating effect had been observed as far back as 1838. Since January last, Mr. Gassiot has had several forms of apparatus constructed for the purpose of observing the phænomena of secondary discharge in relation to its heating effects:—1. If the discharge of the secondary current takes place in air the negative terminal (which in these experiments was of platina wire) became heated. 2. If the wires are sealed into small (thermometer) straight tubing, neither terminal appears to be heated, but the discharge takes place, filling the entire tube with a brilliant clear white light. 3. If any part of the tube is blown into small bulbs, that portion of the discharge which passes through the bulbs is spread as illuminating that portion with a brilliant blue light. 4. If the discharge takes place in a globe, or in a tube of about one inch diameter, the negative terminal is intensely heated. In the course of the experiments Mr. Gassiot noticed that the glass at the heated end became quite black; in fact, the heat of the electrode had fused the glass and also caused a deposit of minutely divided platinum. He therefore had another apparatus constructed, taking care that whenever he experimented with it the current should invariably be sent in the same direction. The result has been that the negative end has become quite black, the deposits being in regular layers, the most dense nearest the wire. The positive end of the glass remains quite clean, as does the platina wire, except about $\frac{1}{12}$ of an inch, which appears covered with a minute black deposit. At this terminal, whenever the discharge is made, a minute but brilliant spark appears, from which the electric brush flows in great beauty and brilliancy. The negative is at first covered with the well-known blue flames until it becomes red-hot; no deposit appears to remain in the negative terminal. In all the experiments made with closed glass tubes, the air was exhausted by means of an air-pump.

On a Method of Analysis applicable to the Quantitative Estimation of Nitric and Acetic Acids. By J. H. GLADSTONE, *Ph.D., F.R.S.*

The method proposed consisted in distilling the substance to be analysed with a very large quantity of sulphuric acid in a retort, and in collecting the condensed distillate in a receiver containing water and carbonate of baryta. The acid is speedily converted into baryta salt, the amount of which can be estimated by the ordinary processes. Various precautions requisite for the proper conducting of the experiment were described. The process was submitted, not as involving any new principle, nor yet as being a perfectly accurate method, but as one which the author had found to be efficient in overcoming one of the difficulties in practical analysis.

On the Fluorescence exhibited by certain Iron and Platinum Salts. By J. H. GLADSTONE, *Ph.D., F.R.S.*

On the Concentration of Alcohol in Sömmering's *Experiments.* *By* Professor GRAHAM, *F.R.S.*

The author stated that when an open vessel is filled with a mixture of alcohol and water and exposed to the air, the alcohol goes off first and leaves the water; but if, as in Sömmering's experiments, a bladder be completely filled with dilute alcohol, the liquid will decrease in bulk, and the water pass through the membrane, leaving a much larger per-centage of alcohol in the bladder. Sömmering describes the action of membrane to be improved by coating it with isinglass. Prof. Graham removed the membrane entirely, and made use of a septum of gelatin itself. Cotton calico was coated several times with a solution of isinglass and allowed to dry. A retentive vessel was thus prepared, in which alcohol in different states of dilution was placed, and kept between 100° and 12° Fahr. for twenty-four hours. Evaporation took place, which was uniformly attended by concentration of the spirit:—

180	grammes	of alcohol	0·860 gave 150	grms.	of 0·854
180	,,	,,	0·860 gave 146	,,	of 0·852
180	,,	,,	0·880 gave 146	,,	of 0·871
180	,,	,,	0·900 gave 154	,,	of 0·888

or, the septum of gelatin alone acted exactly like the coats of bladder. Further, it was observed that dry gelatin (isinglass) placed in alcohol 0·860 increased 11 per cent. in weight, and at the same time lowered the gravity of the spirit to 0·857. There can be no doubt, therefore, that gelatin *per se* separates water from alcohol, and the colliferous tissues possess the same property. In the bladder experiment, the water thus absorbed by the membrane evaporates from the outer surface, and its place being constantly supplied from the dilute alcohol within, the latter comes to be rapidly concentrated.

On the Results of Experiments on the Preservation of Fresh Meat. *By* G. HAMILTON, *F.C.S.*

This inquiry was undertaken with a view of discovering a method by which beef could be brought in a fresh state from South America. The experiments were made by enclosing pieces of beef in bottles containing one, or a mixture of two or more of the following gases:—chlorine, hydrogen, nitrogen, ammonia, carbonic acid, carbonic oxide, binoxide of nitrogen. Of these, the last two only possessed the power of retarding putrefaction. Beef that had been in contact with carbonic oxide for the space of three weeks was found to be perfectly fresh, and of a fine red colour. Binoxide of nitrogen is capable of preserving beef from putrefaction for at least five months, during which time the beef retains its natural colour and consistence. When meat that had been preserved by the last process was cooked by roasting, it was found to possess a disagreeable flavour. If cooked by boiling, the ebullition must be continued for a much greater length of time than is necessary for fresh meat.

Hints on the Management of some difficult subjects in the application of Photography to Science. *By* SAMUEL HIGHLEY, *F.G.S., F.C.S.*

The author gave a survey of the departments of science to which photography had already been applied (including astronomy, meteorology, structure as displayed by polarized light, microscopy, natural history, geology, anatomy, surgery, pathology and types of disease), and demonstrated by a series of photographs what valuable aid might be rendered where *truthful* delineations of natural objects were of importance, as on disputed points of *observation*, and how by the application of stereoscopic principles the student might in his closet study the Flora and Fauna of distant lands, or rare cases in medical experience. He pointed out the means of obtaining microscopical photographs of very thin depolarizing objects by aid of polarized light, and recommended difficult coloured objects, as those abounding in reds, to be illuminated by reflected light of a complementary tint, or where antagonistic colours existed in the same object, as white, blue, and red, to reduce the whole to one tone by means of thin coloured glasses in front of the lens, and thus prevent one part being overdone before another had impressed itself on the plate.

On the Means of applying Photography to War purposes in the Army and Navy. By SAMUEL HIGHLEY, *F.G.S., F.C.S.*

A field camera, with all requisite apparatus, mounted on a large pair of wheels, which, together with the handle, formed the tripod stand, arranged to be *rapidly* moved from point to point and be managed by one person, was described; together with a naval camera suspended by gimbals on a tripod stand, with counterpoise weight and compensating focusing movement, to render it as independent as possible of the ship's motion; the object of both being to report, *by means of pictures*, the position of troops, forts, or other military works.

On the Hyposulphites of the Organic Alkalies. By HENRY HOW.

Mr. How had succeeded in obtaining the hyposulphites of the organic alkalies by digesting them with sulphide of ammonium in open flasks. They are a very remarkable class of compounds, sparingly soluble in water, and highly crystallizable. Those of strychnine and codeine are extremely beautiful compounds.

On a Stereoscopic Cosmoramic Lens, designed by G. KNIGHT.

This is a modification of the instrument invented by Sir David Brewster. The improvement consists in employing, in place of the two small semi-lenses, one large one, which is rendered stereoscopic by cutting an ordinary plano-convex lens in half, removing more or less of the opposite outer diameters, and then transposing the pieces so that the original centre of the lens becomes the two sides, and the outer edges come together in the middle. The advantages obtained by this arrangement is an increased facility for viewing as one the double pictures. Only one adjustment is necessary for all sights, viz. increasing or diminishing the distance between the lens and the double picture.

On the Equivalency of Starch and Sugar in Food. By J. B. LAWES, *F.C.S., and* DR. J. H. GILBERT, *F.C.S.*

On the Amounts of, and Methods of estimating, Ammonia and Nitric Acid in Rain Water. By J. B. LAWES, *F.C.S.*, and DR. J. H. GILBERT, *F.C.S.*

We were indebted to Cavendish for the observation, that ammonia and nitric acid were formed when humid air was submitted to voltaic action. About the commencement of the present century, De Saussure detected ammonia in the atmosphere; a few years later, Chevreul observed its presence in the Seine; and in 1825 Brandes detected it in rain-water. Since that time much more minute attention had been paid to this subject, as well as to the presence of nitric acid in meteoric and other waters. Liebig and Boussingault have particularly called attention to the influence which the ammonia, carried down from the atmosphere, must have upon the growth of plants; and the former of these philosophers pointed out the occurrence of nitric acid also, in a considerable number of the rain-waters which he examined; especially those of thunder-storms. Dr. H. Bence Jones has also found nitric acid in rain which fell in various parts of England and in the South of Ireland. But it is to the more recent labours of Boussingault that we are indebted for our most elaborate quantitative estimations of the ammonia in rain and other waters; and M. Barral has made a series of quantitative determinations of both the nitric acid and the ammonia contained in the rain-water which fell at Paris, during several consecutive months, in 1851. It was chiefly with a view to the agricultural bearings of the subject, that the authors had entered upon the same field of investigation; but the object of the present paper was rather to discuss the methods of analysis, than to rely with confidence on the conclusions to which we might be led, by the more direct application of the results yet obtained, to the solution of the several important scientific and practical questions, upon which they bore. Tables were exhibited, showing the experimental results obtained in the estimation of ammonia in rain-water, by several different methods. In the first instance, they had distilled very large amounts (from 100 to 200 pounds or more) of rain-water, to which a little caustic potash was previously added, and repeated the distillation, collecting in each case about half the amount put into the retort, until the whole was reduced to a convenient bulk for further concentration in an open vessel. This was then evaporated, with a known amount of sulphuric acid, to a given volume; and measured portions of this final product were then neutralized by a standard alkaline solution, in the usual manner of liquid analysis. This method the authors conceived gave very good results; but it had been abandoned from the great practical inconvenience and frequent breakage, in conducting distillations in glass, on so large a scale. They had next adopted a method substantially the same as that of M. Boussingault, in which generally not more than one litre of water was operated upon. By this method, exceedingly minute *actual* amounts of ammonia could be determined, and in careful hands very valuable comparative results might be obtained. It appeared, however, that in relation to the average total amount of ammonia contained in a litre of rain, or other waters, the minimum error was generally not less than 4 or 5 per cent. of such total amount. The authors had therefore, in their more recent experiments, operated upon several litres of water in the first instance; reducing it by successive distillations to one half, until thus brought to a convenient amount, for final distillation—and the testing of measured proportional amounts of the product according to Boussingault's method. This modification, which the authors found M. Boussingault had himself suggested, was considered to be important, and more applicable to this delicate subject of inquiry than any of the others yet attempted. However, results obtained by their first method of large distillation, by the side of those by Boussingault's single distillation process, showed considerable coincidence; such as to give confidence in the general principle of the methods. The average of the determinations made in monthly mixed samples of the rain which fell at Rothanstet during more than a year, gave about 1 part of ammonia per million of rain-water; the average of many determinations made by Boussingault at Liebfrauenberg in Alsace was about four-fifths of this amount; whilst the estimations, both of M. Barral and M. Boussingault, at Paris gave as much as 3 or 4 parts, or even more, of ammonia per million of rain-water. It was interesting too, to notice, that the variations in the amount of ammonia which the authors had obtained, in the rain of different but entire months, when considered in connexion with the registered amounts of the fall, the direction of the wind, and the general characters of the weather, were perfectly consistent in kind with the results of M. Boussingault in his special examinations of rain falling under different circumstances, of the water of dews, of fogs, &c. The process adopted by the authors for determining the nitric acid, was, to evaporate the rain-water with an alkaline carbonate, several times to dryness, to weigh the solid residue, and determine its per-centage of nitrogen by Dumas' direct volume-method of combustion with oxide of copper. With some of the results thus obtained, however, they were not satisfied; and they considered an accurate method for the determination of small quantities of nitrogen, or rather nitric acid, still a great desideratum. They hesitated therefore to apply with confidence, all the results yet obtained, to the discussion of the important questions, with a view to the solution of which the investigation had been undertaken, and which they hoped further to prosecute. As a general result, however, it would seem that the per-centage amount of ammonia was generally less in rain of thunderstorms, and when there had been a large fall of rain; the amount of nitric acid, on the other hand, seemed to be increased under the influence of storms. The results further indicated, that the amount of nitrogen yielded by rain-water in the form of nitric acid, was considerably greater than that which existed as ammonia; and, since there could be no doubt that nitrates applied as manures greatly enhanced the growth of plants, by virtue of the nitrogen they contained, the amount of nitrogen brought down from the atmosphere in the form of nitric acid, must be considered to have a very important influence on vegetation.

Note on the Presence of Lead in Hydrochloric and Nitric Acids.
By STEVENSON MACADAM, *Ph.D., F.C.S.*

In the course of some analyses made with the view of determining, if possible, the presence of lead in animal organisms, the author saw reason to suspect that the acids employed by him might contain lead. On testing these—which were the purest to be purchased from manufacturers—small but very distinct indications of lead were obtained. In commercial or impure specimens of hydrochloric and nitric acids, the lead is much more abundant. The importance of such a discovery in reference to searching for metallic poisons in organized tissues is so great, that the author would caution analytical chemists against the use of the acids for such purposes without previously testing them for lead.

On the Distribution of Iodine in the Mineral, Vegetable, and Animal Kingdoms.
By STEVENSON MACADAM, *Ph.D., F.C.S.*

The author stated, that an experiment where 100,000 cubic feet of air were analysed; a second, where 80 gallons of rain water were examined; and a third, where 36 gallons of snow-water were tested, having failed to exhibit the minutest trace of iodine, he was satisfied that other and more carefully conducted experiments than those advanced by Chatin and his adherents were required before the statement of the presence of iodine in appreciable quantity in our atmosphere could be admitted. Though rain water appears free from iodine, yet some spring and river waters contain a trace. In 100 gallons of the water forced into the houses of Edinburgh, and there used for domestic purposes, the author discovered a minute quantity; and the ocean, as well as marine plants and animals, have been long known to contain the element in question. Terrestrial plants have more lately shown indications of its presence, and Chatin and the author have published separate lists of a large number of such plants. In examining plants and animals, the author refrained from adding any re-agent for the purpose of more immediately fixing the iodine, as he was not aware of any which would have been serviceable, without at the same time endangering the admission of that substance. In this, the present researches on the presence of iodine in plants and animals differs from any other which have been published. Chatin and others drenched their plants with potash previous to incineration, and though the author does not question the presence of iodine in the few plants which they examined, yet he does not consider the process followed by them a good one.

In examining the plants, they were simply *charred* in a large covered iron crucible or chamber, carefully heated to a low red heat. On cooling, the charred mass was ground to powder, and digested in water, which dissolved out all the soluble salts, and amongst these any alkaline iodide which the plant contained. On evaporating this liquid to dryness, a variable quantity of saline matter was left, which was treated with alcohol, heated, filtered, again evaporated to dryness, and ultimately dissolved in a very small quantity of water. This liquid was tested with starch, nitrate of potassa, and hydrochloric acid. Proceeding in this way, the author demonstrated the presence of iodine in upwards of sixty plants, many of which are edible. Potatoes, wheat, barley, oats, beans, and peas afford a trace, and the ashes of the pear, the gooseberry, and the apple trees do so likewise.

The presence of iodine in the food of animals necessitates its introduction into the system of the animal, and for a time at least its retention there. In the earlier trials the animal matter was burned, and the ashes examined, but in no instance was iodine found. Latterly, however, by adopting the system of charring, so successfully followed in testing plants, the author obtained minute but quite distinct indications of the presence of iodine in the cat, the dog, the pig, the cow, the horse, and man. In every instance but one muscle was the only part of the animal frame employed. In the horse, however, the lungs, liver, heart, spleen, and kidneys, as well as the muscle, were examined, and each organ yielded iodine. The milk and blood of the cow, and common eggs, treated in a similar manner, gave a like affirmative result.

Although not wishing to be considered as giving a positive opinion on the chemical condition in which iodine exists in vegetable and animal matter, the author thinks it worth while to notice, that, notwithstanding the same treatment being followed, he failed to find any iodine in new and fresh eggs, whilst in rotten eggs a very distinct quantity was detected. Now, whilst it is quite possible, and indeed probable, that from some slight and unknown cause, the iodine in the fresh eggs might have escaped, yet the author could not help speculating so far as to say, that the iodine in the fresh egg may exist in the *free* condition, or at least, not in combination with a metal; and that when the egg rots, the sulphuretted hydrogen produced may convert the iodine into hydriodic acid, which in the presence of the free soda of the egg will become iodide of sodium, a substance very much less volatile than iodine itself.

The passage of iodine from the animal system has also occupied the attention of the author. With no expectation of a successful result, but wishing to be able to speak experimentally on the subject, he wore a light, starched, gauze respirator for six nights, during which time (about fifty hours) the air inspired and expired must have come in contact with the starch. No blue or even rose tint was imparted to the gauze, and therefore no iodine had left the system by that road. Other experiments showed that the iodine compounds form no exception to the general rule, and accompany the other saline matters in their passage from the animals.

Whilst the animal receives what iodine it requires from the plant, the latter in its turn, no doubt, obtains its supply from the soil: direct experiments are still wanting to substantiate its presence there, but the fact of its being uniformly a constituent of limestone rocks, necessitates, that when these are present in or applied to a soil, the latter must, to a greater or less extent, contain iodine.

On the Cause of the Phænomena exhibited by the Geysers of Iceland.

By STEVENSON MACADAM, *Ph.D., F.C.S.*

The present memoir, though specially bearing on the Iceland Geysers, is also intended to explain those found in California. The former are singled out, because our knowledge of them is somewhat extensive, and we are in a position to speak more confidently regarding any cause or force which may be urged in explanation of them. The phænomena to be accounted for are occasional jets of hot water, and steam projected with great force from beneath the surface of the earth, and alternating with comparatively lengthened periods of repose, during which all is quiescent. In endeavouring to explain the cause of the phænomena in question, the author assumes that there exists in connection with each geyser, a subterranean chamber of large size; the floor of which is of a roundish form, and at a temperature of not less than 310° F. At or near the roof there are fissures communicating with springs or reservoirs of water, by which the latter may be allowed to flow into the chamber; the pipe or tube which passes from this cavity to the surface of the earth, taking its rise from near the lowest part of the chamber. Without entering into details, the author assumes (as other writers on the geysers have done) that this tube has the form of an inverted siphon, the shorter limb of which communicates with the chamber, whilst the longer limb, assuming a tortuous course, at length forms the exit or emission tube of the geyser. In the course of events, water finds access by the fissures into the cavity, where, from the high temperature of the matter it falls upon, it is immediately compelled to assume the spheroidal condition, its temperature while in that state being 205°·7 F. The water gradually accumulates, till at last so much has entered the cavity that the mineral floor can no longer keep the liquid in the spheroidal state; the water in consequence touches the stony surface; its temperature is almost instantly raised to 212° F., and large volumes of steam are generated. This steam in its passage to the mouth of the geyser encounters water lodged in the windings of the conduit; in this water the first portions of steam are condensed, till the whole is raised to the boiling point, when the steam, no longer compelled to lose its gaseous state, presses on the column of water and propels it from the exit pipe. Having thus cleared a path for itself, the remainder of the steam escapes with a sound more or less violent. The author exhibited several diagrams illustrative of the forms which the several geysers might be supposed to present. He considered it quite probable that some points in their arrangement might require to be altered, and what he wished specially to impress on the Association was, that the spheroidal condition of water afforded a means of accounting for the occurrence of the *intermittent hot-springs* generally denominated Geysers.

On the Presence of Lead in Hydrochloric and Nitric Acids. *By* STEVENSON MACADAM, *Ph.D., F.C.S.*

In the course of some analyses, made with the view of determining, if possible, the presence of lead in animal organisms, the author saw reason to suspect that the acids employed by him might contain lead. On testing these, which were the purest to be purchased from the manufacturers, small but very distinct indications of lead were obtained. In commercial or impure specimens of hydrochloric and nitric acids, the lead is much more abundant. The importance of such a discovery in reference to searching for metallic poisons in organized tissues is so great, that the author would caution analytical chemists against the use of the acids for such purposes, without previously testing them for lead.

On the Preservation of Milk. By the ABBÉ MOIGNO.

This was a description of the process invented by M. Mabbru, which consists in expelling the air and gases from milk by heating it in tinned or glazed iron cylinders to a temperature of 217°, in an atmosphere of steam.

On the Estimation of Iron by the Method of Marguérite, and some Notes on the Preparation of the Standard Solution of Permanganate of Potash. *By* E. C. NICHOLSON and DAVID S. PRICE, *Ph.D., F.C.S.*

The authors stated that an objection had been made to the process proposed by Marguérite, to the effect, that the standard solution of the permanganate of potash was constantly changing, and that it was therefore necessary frequently to affix a fresh value to it. They believed this was owing to its containing manganate of potash, a much less stable compound than the first-named salt, and that they had found that a solution prepared either from crystals of the pure permanganate of potash or by the method of Gregory,—care being taken in this case that the whole of the manganate was converted into the per-salt—would remain unaltered during a period of many months. They also showed that the method at present adopted for fixing the 'standard' of such a solution, by dissolving iron-wire in hydrochloric acid, led to an erroneous result, from the reducing action exerted by the impurities in the iron upon the permanganate; and that it was necessary to employ pure peroxide of iron for this purpose.

They gave several other details connected with the employment of this test.

On the supposed influence of the Hot-Blast in augmenting the quantity of Phosphorus in Cast Iron. *By* DAVID S. PRICE, *Ph.D., F.C.S.*

Dr. ASTLEY P. PRICE communicated a paper on a new method of Alkalimetry, which consisted essentially of the following:—To the alkali under examination a known quantity of a normal solution of oxalic acid is added, and after expulsion of carbonic acid, the excess of the oxalic acid is determined by means of a standard solution of ammonia. By this method when applied to the testing of commercial alkalies, the impurities are directly estimated and the alkali indirectly, and constituting as the impurities invariably do by far the smaller proportion of the commercial alkalies, the valuation of their neutralizing power is more easily and accurately determined by this than by the usual method.

Mr. **Sims** exhibited specimens of borate of lime, and stated that the nucleus of some of the pieces consisted of magnesian limestone; that they were also sometimes coated with crystals of nitrate of soda, chloride of sodium, glauberite and iodide of sodium. The presence of iodine was demonstrated.

On the Production of Sulphurous Acid Gas from the Combustion of Coal.

By Joseph Spence.

The author questioned the great benefit likely to be derived from the abolition of the smoke nuisance. The imperfect combustion of fuel, as carried on at present, only led to an annoying deposit of carbon, and this Mr. Spence regarded as a healthy body. By the more complete burning of the fuel, this carbon would be oxidized into carbonic acid, a poisonous gas, and the sulphur at present escaping combustion would pass into sulphurous acid. He instanced the smoke-consuming movement in Manchester, and observed that vegetation in the neighbourhood was being destroyed, owing to the very much larger quantity of carbonic and sulphurous acids which were now thrown into the atmosphere.

Some discussion ensued when this paper was finished, and Mr. **Lowe** remarked that those parties who did not admire smoke might obviate the inconvenience by consuming gas coke, as was done in the noble hall where they were assembled.

On a new Electrical Battery. By W. Symons.

The battery exhibited by Mr. Symons was composed of a series of plates made of a mixture of gutta-percha, bees'-wax, and shell-lac. A description of this battery will be found in the Pharmaceutical Journal for July of the present year.

On the Re-cutting of the Koh-i-Noor Diamond.

By Professor J. Tennant, *F.G.S.*

At the meeting of the British Association at Belfast, the author gave some account of this diamond, and described some of the remarkable changes which it had undergone, and on this occasion exhibited some interesting diagrams illustrating the crystalline form and cleavage of the diamond. Mr. Tennant now introduced the subject by drawing attention to the former weight of the diamond, compared with its present bulk, now reduced by cutting; and also to its mineralogical appearances. With regard to the history of this extraordinary gem, he stated that some people had actually disputed its authenticity, which caused some discussion amongst those best informed in matters of this description. At the Great Exhibition in 1851, an opportunity had been afforded, such as was never previously enjoyed by the public, of studying the substance of a vast number of foreign valuable stones, and probably the Koh-i-Noor diamond was the most attractive in that valuable collection. The rough manner in which that diamond had been cut, however, had disappointed many who looked upon it. When the sun shone on it at noon-day the stone appeared peculiarly brilliant; but when the atmosphere was dull, it had merely the appearance of a thick piece of glass. This placed it in a very unfavourable position, and caused doubts to arise in the minds of some gentlemen as to its authenticity This diamond originally belonged to Runjeet Singh, who usually wore it upon his left arm, according to the custom of Eastern potentates; and the original mounting was now in the hands of Her Majesty's jewellers. The stone perfectly agreed with the drawing which had been made of it by Miss Eden, and also with the account given of it by the Hon. W. G. Osborne, who had published a very interesting description of the Court of Runjeet Singh, where the old man (who was blind and a cripple also) sat arrayed in a robe of simple white, wearing upon his arm the Koh-i-Noor diamond, and surrounded by his eastern nobles. On special occasions, Runjeet Singh was in the habit of decorating his horse with this precious gem, together with numerous other valuable stones, mounted upon various parts of his harness. All authentic accounts of the East proved that the nobles were in the habit of decorating their horses in this manner; and the horse of Runjeet Singh was decorated with diamonds valued at £300,000, the great Koh-i-Noor being placed on the pommel of the saddle. Lord Auckland and his sister, the Hon. Miss Eden, had this diamond sent to them for inspection in the East Indies, and Miss Eden's drawings agreed with the appearance of the diamond on its arrival in this country. Mr. Tennant then stated that in 1853 he had given in a report as to the cutting of the Koh-i-Noor diamond; and after producing various models, Her Majesty fixed upon the present form, by which the widest spread of brilliancy was obtained. When the diamond was exhibited at the Crystal Palace it weighed 186 carats; its present weight, reduced by cutting, is only $102\frac{1}{16}$ carats. The Persian diamond weighed 130 carats, and the great Russian diamond 193 carats. After giving a description of the method of cutting diamonds, and the plan adopted for cutting the Koh-i-Noor, he observed that the late Duke of Wellington had been an interested spectator of the operation, and was a frequent visitor during its progress. It was finished in September 1852, and occupied thirty-eight days in cutting. Diamonds were usually reduced to one-half their weight in cutting; and he gave the exact weight of the Koh-i-Noor, in order to correct various erroneous statements which had been published on the subject. The finest diamond in France weighed 139 carats, and had cost £130,000; it was called the Regent, or Pitt Diamond. To arrive at an estimate of the value of the Koh-i-Noor, the author stated, that it was only requisite to multiply 102 (its weight) by 102, and then by 8, which would give £83,232 as its value. This rule would not apply to stones having defects, as instanced in the celebrated "Nassuck" diamond, for which the East India Company refused £30,000, and yet this stone, when submitted to public auction, fetched little more than £7000. The Koh-i-Noor is of the purest water. The author stated, that in order to test a real diamond, and distinguish between that and a topaz, it was necessary to try it with sapphire (No 9 in hardness), which would mark a topaz, but would not penetrate a diamond. He was sorry to find that so little attention had been paid to the means of testing diamonds; and instanced a ring which was recently purchased in Regent Street, London, for £200, which proved to be two pieces of rock crystal, with an intermediate insertion of coloured glass. In many of our watering-places the gentry were imposed upon by parties selling pieces of glass, which they represented to be sapphires picked up on the beach.

On the Physiological Properties of some of the Compounds of the Organic Radicals—Methyle, Ethyle, and Amyle. By JAMES TURNBULL, *M.D.*

The author commenced by saying, that considering the vast number of new compounds discovered of late years, it was surprising that so few of real value should have been added by medical men to their stores of remedies. The progress of therapeutics, though disproportionately slow when compared with the advance of organic chemistry, was marked in our day by the discovery of a new and most valuable class of agents —the anæsthetics. The effects of the narcotic and antiperiodic alkaloids, morphia and quinine, were well understood; but nothing was known of any relation that may exist between their chemical constitution and the different actions they exert on the animal œconomy. It is probable that an examination into the action of the artificial alkaloids upon the system would throw some light on this subject. Already one of them, furfurine, has been found by Dr. Simpson to possess antiperiodic properties like quinine. The physiological properties of the pure hydrocarbons were then alluded to: several of them were stated to act as local and general stimulants, and some of the volatile ones had been found to possess anæsthetic properties, as had been demonstrated by Dr. Snow and Mr. Nunnerley with regard to benzine, and by the author with eupion and Persian naphtha.

On the Production of Boracic Acid and Ammonia by Volcanic Action. By R. WARINGTON, *F.C.S.*

The author stated that in 1841 a friend of his had visited the island called Volcano, situated about twelve miles north of Sicily. The height of the mountain Volcano is 2000 feet, and the depth of the crater 700 feet. The sides of this depression are covered with a white snow-like substance about one inch in thickness, beneath which is a fused lava similar in appearance to the slag of a glasshouse. The boracic acid rises in vapour and condenses on the surface of the ground or in crevices at the bottom of the crater, from which about 2000 tons are annually removed. It occurs connected with sal-ammoniac, and the author considers that it exists originally beneath the surface as a nitride of boron. When steam is passed over this compound at a moderate red heat, it is completely converted into boracic acid and ammonia, which are for the most part volatilized with the aqueous vapours. This theory of the formation of boracic acid was considered by the author substantiated by the analysis of the slag beneath and the snow-like mass above. The former contained nitride of boron, and the latter boracic acid and ammoniacal salts.

On the Effect of Coloured Media on the Growth of Red Algæ.
By R. Warington, *F.C.S.*

On the Artificial Preparation of Sea-water for Marine Vivaria.
By G. Wilson, *M.D.*

The paper was a criticism on a communication made by Mr. Gosse, and contained in the 'Annals of Natural History.' Guiding himself by Schneitzer's analysis, Gosse employed chloride of sodium, sulphate of magnesia, chloride of magnesium and chloride of potassium. Into a mixed aqueous solution of these salts, Gosse introduced various species of marine plants and animals; and for six weeks they throve and flourished. Dr. Wilson considers, however, that the less abundant, but still essential, constituents of sea-water—such as carbonate of lime, sulphate of lime, phosphate of lime, fluoride of calcium, silica, iodine, and bromine—should not be absent, as these latter substances are found in marine plants and animals; and it is therefore plainly evident that the medium in which they live ought to contain the same substances. It is, of course, quite possible that in a single aquarium the death of a certain portion of the animals might furnish calcareous salts, &c. for the growth and preservation of their survivors; and in like manner the death of a given number of plants might liberate iodides, bromides, &c., for the remainder. But this destruction of part of the occupants of the aquarium for the preservation of the other part might be easily avoided, as calcareous phosphates, carbonates and fluorides occur together in shells, corals, and many limestones. The arrangement of fragments of such calcareous bodies at the bottom of the aquarium would supply some of the missing ingredients; whilst pieces of trap rock and a few grains of an iodide or bromide would afford the remainder.

On the Sewerage of Manufacturing Towns.
By Francis Wrightson, *Ph.D.*

The analysis made by Dr. Wrightson of a natural deposit from the sewerage of Birmingham, formed near the embouchure of several sewers opening into the Rea, showed the absence of all ammoniacal salts, and the scarcity of phosphates, particularly alkaline phosphates, and at the same time the presence of a large quantity of protoxide of iron, also of zinc, copper, and other metals in the state of oxides and sulphurets. These metallic salts in the sewers absorb the sulphuretted hydrogen and ammonia generated by decaying vegetable and animal matter, and doubtless contribute to promote the health of the town. The deposit contained when dried only 1·4 per cent. of nitrogen (not as ammonia) and 3·5 of earthy phosphates; but about 11·7 of protoxide of iron, besides zinc, copper, and other metals to the extent of two or three per cent. The author hoped these facts would not be lost sight of by corporations and other bodies interested in œconomizing town sewerage.

GEOLOGY.

On a curious Structure in the Silurian Slates of Peebleshire. *By* A. BRYSON, *F.S.A. Scot.*

MR. BRYSON exhibited specimens from the slates of Peebleshire, being very remarkable convoluted markings, which he at first referred to impressions of *Graptolites Nicolii* of Harkness. The depth of these convolutions, however, rendered the supposition inadmissible. The only other method of accounting for these appearances was by supposing them worn tracts filled up by matter deposited in them of a different molecular arrangement from the surrounding matrix.

Prof. BUCKMAN communicated a notice of two elephants' tusks found in the Stroud Valley, Gloucester. The largest was slightly curved, 10 feet long, 3 feet in circumference, and 1 foot 6 inches in its greatest diameter; the other tusk was curved to a greater extent. Remains of rhinoceros and hippopotamus were found in the same gravel.

Prof. BUCKMAN also sent an account of coal deposits in West Virginia. They occurred on the banks of the tributary of the Ohio, 300 miles from Pittsburg, and 150 from Cincinnati, and were covered by new red sandstone. There were five seams of coal, with a total thickness of 20 feet; one bed of splint coal was 10 feet thick. They contained Calamites, Stigmariæ, and true coal-measure ferns. The grits below were like those of the Welsh coal-field, and nearly horizontal. At the top there was a little band of limestone, with Cyprides, like the Ardwick limestone of the Lancashire coal-field.

Mr. P. P. CARPENTER communicated a Notice of Land, Freshwater and Marine Shells, obtained from Miss Bright of Malvern, 100 feet deep, in sinking a well on the banks of the Avon, at Birlingham, Worcestershire. According to Mr. J. Faulkner, the well-sinker, after passing through many gravel beds, the upper mixed with marl, a bed of rounded flints was met with, from 2 to 4 feet thick, containing teeth and fragments of bones of deer, elephant, rhinoceros, hippopotamus, boar, &c. At the bottom was a thin layer of sandy mud, with freshwater shells and rushes. The land and freshwater shells were existing British species of the genera *Pupa*, *Succinea*, *Limnæa* (3 sp., including *glutinosa*), *Ancylus*, *Valvata* (2 sp.), *Bithinia*, *Cyclas* and *Pisidium* (4 sp., including *Henslowianum* in great abundance); the marine shells were *Pectunculus glycimeris* (rare), *Ostrea edulis* (young), *Pecten* (fragment), fragments of some sort of whelk, and two minute, undetermined bivalves, quite distinct from any known, either recent or in the crag. One is an *Astarte*, very flat and triangular, with sharp ribs, like *Gouldia Pacifica*, C. B. Ad. The other is a ? *Lucina*, somewhat the shape of *L. columbella*, with a deeply-cut lunule as in *Opis*, beginning with concentric ridges, then suddenly changing into radiating ribs. Drawings of these were exhibited.

On the Great Terrace of Erosion in Scotland, and its Relative Date and Connexion with Glacial Phænomena. By ROBERT CHAMBERS, *F.R.S.E., F.G.S. &c.*

This terrace is very conspicuous, at 20 to 30 feet above the sea, along the Frith of Clyde, the Islands of Bute and Arran, and coast of Argyle, but is less remarkable on the east coast of Scotland. The shells found on it are all of recent species. On the west coast the hills generally slope smoothly to the present beach, broken only by the well-defined rectangular cut of the great terrace, which forms a level platform, seldom less than 100 feet wide, at the base of a vertical cliff, often 40 feet high. The cliff is perforated by many caves, and sometimes rough with overhanging stones; whilst fantastic masses of harder rock occasionally rise up from the platform. This terrace is considered to indicate the sea's action during a much longer time than the present beach has existed, and to have been formed at a period of some comparative geological antiquity. On the north-west coast of Arran the ancient sea-cliff is 50 to 100 feet high; and the opening of Glen Iorsa is filled to a considerable height with terraces of detritus. The lower part of this detritus is composed of blue clay and small half-worn boulders: over it is a bed of coarse gravel and then fine sand. Some of the detritus has been thrown over on the face of the cliff itself, showing its origin to have been posterior to the incising action of the sea, by which the terrace was formed. The surface of the drift is not less than 140 feet above the sea-level, and it is considered to be the product of a glacier once filling Glen Iorsa. The coarse sand and gravel indicate periods at which the land occupied different levels and the sea penetrated into the valley; thus it becomes clear that the date of the terrace of erosion is anterior to the period of sub-aërial glaciers, and that this again has been followed by an immersion; a succession of events requiring a great length of time.

Farther Observations on Glacial Phænomena in Scotland and the North of England. *By* ROBERT CHAMBERS, *F.R.S.E., F.G.S. &c.*

The author referred to his former attempt to establish a distinction between an early general operation of ice over the surface of Scotland, by which the boulder clay was formed, and a more recent presence of valley glaciers in the chief mountain-systems, bearing as its monument a looser and coarser detritus, like the moraines of the Alps. The latter is supposed to have taken place without the presence of the sea; the former with the sea or with ice covering so large a surface as not to allow of drainage,—just as on the west coast of Northern Greenland, Dr. Rink has shown that continental ice of vast thickness is continually advancing from the interior to the coast, and there breaking off in icebergs.

Additional examples of true moraines, or sub-aërial glacial deposits, have been observed in two of the valleys of Ben Macdui, Aberdeenshire, where conspicuous terminal moraines occur at various stages; in Glen Dearg four of these occur, a mile or two apart,—the height of one of them is 130 feet, the bottom of the valley being about 1700 feet above the sea. In the valley of the Dee, the lateral vale of Muick has also a remarkable series of moraines at a much lower level. In the Tay valley below Aberfeldy, not more than 300 feet above the sea, there is moraine matter; and near Garth Castle are some more recent terminal moraines of the same glacier. These and other examples show that glaciers have been in Scotland, wherever the mountains approach 3000 feet.

Another class of Scottish moraines is connected with shallow recesses of the more elevated mountains, being placed in front of them, as if masses of snow had gathered till an outward movement took place, carrying coarse detritus for a few hundred yards. One of these exists in Benmore Coigach, near Ullapool, and the moraines which confine Lochs Whorral and Brandy are of the same class. Loch Skeen, Dumfriesshire, is formed by another such moraine, the hills being 2600 feet high, and the lake 1600 feet. In front of a similar recess to the westward are other lines and humps of detritus; but there is no lake, the water having escaped by a passage still as clearly defined as a gate in a wall. A similar recess-moraine occurs in the valley of Loch Ranza, Arran, 50 feet above the sea, a furlong in length, with an opening in the centre; the recess is occupied by a morass.

In the lake district of England the author had obtained additional evidence of glacial action in the Thirlmere valley, where it enters the cross valley below the Pass of Dummailraise, which connects it with the Grasmere valley. There is a remarkable double ridge descending the hill side, about 30 feet high, its surface bristled with blocks, like the train of detritus of a glacier 300 or 400 feet deep, coming down the Thirlmere valley; further down are other heaps of detritus along with rounded and scratched rocks.

The author's last observations on the two sets of glacial phænomena were made at the Scotch mountain Schiehallion, which rises from a base 1100 feet above the sea to the height of 3600 feet, and is composed of quartz rock. It is abrupt to the westward, and tails away to the east; the top of the ridge is thickly strewn with loose slabs. About half-way up, and above the level of Ferragon, the highest mountain to the eastward, there are examples of striated surfaces, and others within a few hundred feet of the summit; the direction in both instances being west 30° north, or the same as that of the mountain ridge. About 800 feet below the summit a block of granite was found, and other foreign blocks were noticed in several places. These facts show that the whole mass of this lofty hill has been involved in the general glacial action. The detritus of the neighbouring valleys is of the kind produced by sub-aërial glaciers; but at the Pass called White Bridge, the summit-level east of Schiehallion, there is a deep bed of true boulder clay with many worn and striated blocks; it lies out of the way of valley glaciers, and has escaped removal by their agency.

Mr. Charlesworth exhibited and described several new vertebrate fossils:—1. Vertebræ, supposed to be cetacean, from upper greensand of Cambridge, in the cabinets of the Rev. T. Image and Mr. Reed, of York. Their structure was extremely dense, and the ends marked with radiating grooves as in mammalian vertebræ, which have lost their epiphyses. The bodies of these vertebræ were depressed, giving an elliptical section, and on the dorsal surface was a ridge instead of the usual spinal canal. The vascular foramina were large. 2. Part of the lower jaw of a new mammal (*Stereognathus ooliticus*, Ch.) from the Stonesfield slate, in the cabinet of the Rev. J. Dennis, of Bury. This was the fifth quadruped of the Stonesfield slate, and must have been twice the size of any of the others. The specimen was part of the centre of one division of the lower jaw; its curvature was very slight, and the concavity below. The section, where it was broken across, was rectangular, and as wide as deep. The surface presented no trace of sutures or vascular lines. Three teeth remained, occupying half the length of the fragment, and one of these had six similar cusps arranged in two rows. 3. The skull of a new mammal, named *Platychærops Richardsonii* (Ch.) from the London clay of Herne Bay; about the size of the Hyracotherium, but quite distinct, having very prominent zygomatic processes, and the crowns of the molar teeth being furnished with one large tubercle occupying two-thirds of the surface, and several small complicated tubercles inside. 4. *Teleosaurus ischnodon* (Ch.), a new species, in the Museum of the Yorkshire Philosophical Society, with teeth very closely crowded, leaving only a slender bony partition between the sockets.

On some of the more Recent Changes in the Area of the Irish Sea.
By the Rev. J. G. Cumming, *M.A., F.G.S.*

All the recent changes in the relative level of land and sea, indicated in the Isle of Man, appear to have extended to the surrounding coasts of Britain and Ireland. The period of the boulder clay was marked by a cold climate and the subsidence of the island and surrounding coasts to the extent of at least 1600 feet; and, during the re-elevation of the country, there was an interval, when the land was stationary at about 15 feet above its present level. The sea-bed of the great drift gravel was then left dry, forming an extensive treeless plain, connecting the Isle of Man with the surrounding countries, England being at that time united to the Continent. This was the second elephantine period, in which the great Irish stag (*Cervus megaceros*) became an inhabitant of the Isle of Man, along with other animals whose remains are found in the freshwater marls occupying basin-shaped depressions in the gravel plain. The marl basins and the plains themselves were afterwards covered with vegetation, and are still often occupied with beds of peat, containing forest trees; but, during the same period, the sea was quietly eating back its way into the terrace of drift gravel, until the Isle of Man became insulated and the further immigration of animals and plants was arrested. Cliffs of drift gravel occur on all the coasts of the island, sometimes capping the hard rocks, at others retiring a little distance inland. The form of the channel, and the greater waste of the pleistocene deposits in the south of the Isle of Man, show that the action of the sea was chiefly from the south; and its higher level is proved by the numerous water-worn caves, above the highest modern tides, along the whole southern and western shores. A still later change is indicated by the submerged forests, on many parts of the coast, which appear to have grown after the formation of the gravel terrace, during a temporary elevation, by which the bed of the Irish sea was once more laid dry. Whether the last subsidence took place during the historic period is a question yet to be determined.

On the Submarine Forest, Leasowe. *By* JOHN CUNNINGHAM, *F.G.S.*

A section of the strata of the alluvium to the depth of 56 feet was exhibited in the following descending order, viz.—

First boring on the Marsh.

Surface.

28 feet.	2 ft.	Sand.
	4 ft.	Peat in which the trunks of trees are imbedded.
	2 ft.	Stiff blue clay in which the trees grew.
	16 ft.	Red clay intermixed with turf at top, below with blue veins and sand veins.
	4 ft.	Quicksand penetrated to the depth of 4 feet only.

Second boring about 8 *feet under the surface level of the Marsh outside of the base of embankment.*

10 ft.	Red clay mixed with blue veins and sand.
38 ft.	Brown clay with sand beds from 2 to 3 inches thick, and from 5 to 7 feet apart.

The circumstance of trunks and roots of large trees being found below low-water level, has induced a belief that a subsidence of the shore at Leasowe, the opposite shore at Formby, and of the estuary of the Mersey has taken place from deeply-seated subterranean action similar to what is now going on in the south of Sweden.

If the subsidence of those places referred to be due to deeply-seated subterranean action, then the rocks at New Brighton lying a little way to the south of the space operated on, as also Hilbre Islands and Hilbre Point, the latter immediately adjacent to the submarine forest, all composed of the new red sandstone, would have manifested some degree of sympathy with the area under the depressing influence, but no such evidence exists in any of those places. They maintain the same elevation they had centuries ago, while, on the contrary, the shores adjacent are known to have subsided several feet within the last thirty years. The cause of this subsidence must therefore be referred to some other operating agent or agents than to subterranean action.

The borings recently made under his superintendence, of the strata in the alluvium shown in the sections, prove their permeability to water, being composed of sand and clay beds alternately to a very considerable depth.

The abrading action of the tidal currents on the edges of the strata prepares a ready means of escape for the water and sand from underneath the clay during the refluxes of the tides, and the hydraulic pressure of the water at a higher level in the permeable strata, forces the sand from underneath the clay beds; hence the subsidence of the shore, &c.

The clay bed near the surface in which the trees grew, together with the superimposed peat or vegetable matter, resist the abrading power of the water longer than the other materials. They therefore remain on the surface and descend conformably, with the lower strata undermined, and consequently become submerged even under the level of low water.

Abrasion of the surface of the shore takes place also to a considerable extent by the alternate frosts and thaws that occur during the winter months.

The submarine forest on the Formby shore is supposed to be due to the same causes that operate at Leasowe.

A section was shown of Bidston Marsh, which forms a continuation of the flat shore at Leasowe, having also the remains of an ancient forest imbedded in peat in a similar manner. The levels taken of the surface upon which trees now grow in the S.E. corner of the marsh, and of the surface upon which the roots of the ancient trees exist, prove the difference to be only 18 inches, *i. e.* the surface upon which the living trees now grow is 18 inches higher only than the surface upon which the forest trees flourished, and therefore Mr. Cunningham conceived that forest trees could flourish as luxuriantly on the present surface of the marsh as those of the ancient forest.

Mr. Cunningham had entered into some speculations as to whether the extensive flat lands on both sides of the estuary were encroachments of the land upon the sea, how far those encroachments extended, or whether the whole of the flat lands were not simultaneously elevated to their present level. These questions, although interesting and intimately connected with the subject of the submarine forest, were left for future consideration.

On an Ichthyoid Fossil from India. By Sir PHILIP EGERTON, *Bart.*

Sir Philip Egerton stated the results of his examination of what had been sent to the Section as "a fossil tooth from India," by Mr. Oldham. From the examination he had made, he was convinced that the organism was not a tooth, but a dorsal scale of some large ganoid fish, the species of which had not yet been ascertained.

On the Discovery of Microscopic Shells in the Lower Silurian Rocks. By Prof. EHRENBERG. (*Communicated by* LEONARD HORNER, *F.R.S.*)

The minute grains of greensand, which are characteristic of many rocks, have a different nature from the green earth often met with in concretionary masses. The former, from the *glauconie* of the Paris *calcaire grossier* to the azoic Lower Silurian greensand near Petersburg, appears to consist of green opalescent casts of Polythalamia, composed of a hydrosilicate of iron. The cretaceous greensands of England contain, unmistakeably, these stony casts. In the *calcaire grossier* and nummulite limestones occur beautifully preserved and perfect examples of *Quinqueloculina*, *Rotalia*, *Textularia*, *Grammostoma* and *Alveolina*. In the Lower Silurian greensand casts of detached cells of *Textularia* and *Nodosaria* were found.

On the Foliation of some Metamorphic Rocks in Scotland.
By Professor EDWARD FORBES, *F.R.S.*

It was of great importance to geologists to distinguish between lamination, cleavage, and foliation: the first resulted from original planes of deposition; the second was a superinduced structure, dividing rocks into laminæ of similar constitution, not coincident with the lines of bedding; thirdly, foliation was the division of a rock into laminæ of different mineral condition. Cleavage had been attributed by Prof. Sedgwick, its first definer, to electrical action; by Mr. Sorby, to a mechanical force; and by Mr. D. Sharpe, to mechanical and chemical influence. The foliation of mica slate, or separation of its mineral constituents into distinct layers, had been sometimes attributed to metamorphic action on layers of different constitution; Mr. Darwin had considered it identical with cleavage, and due to the same cause,—the one passing into the other: the same view has been maintained by Mr. Sharpe. Prof. Forbes agreed with those who considered it a superinduced structure quite distinct from cleavage or lamination.

The author then referred to examples of foliated structure; in a roadside quarry at Crianlarich, near the head of Loch Lomond, where the metamorphic limestone is not distorted, and exhibits distinct lines of bedding, of a pale blue colour, caused by the presence of iron; also lines of different mineral matter, the laminæ frequently curved round nuclei; and dark lines of crystals of calcareous spar produced, perhaps, by the metamorphism of bands of fossils. In the upper part of the quarry the limestone becomes foliated with mica,—the foliation being at first parallel with the bedding, then becomes wavy and contorted, is affected by small faults, and contains nuclei of calcareous spar, and at length passes into a mica slate. At Ben Os there is a calciferous band in the mica slate, which, having the same strike with the Crianlarich beds, may eventually prove a guide in unravelling the structure of the country. Two miles from Inverarnon there is a bed of porphyritic trap in mica slate, and the foliation on the sides of the trap is conformable. Four miles from Inverarnon, in a quarry of trap, which sends large and small veins into the mica slate, there is evidence of a second foliation having taken place, following the small veins of trap. Near Tarbert the mica slate is foliated and contorted; and a bed of calcareous grit cuts through it, without disturbing the relations of the curves and laminæ. In a slate quarry at Luss, the foliation accords in the main with the cleavage, as observed by Mr. Sharpe, in the corresponding district; but whilst the foliation curves round the nuclei of quartz, the cleavage abuts against them. Foliation has also been noticed in the baked rocks of Salisbury Crags.

Prof. Forbes concluded,—1, that foliation was a superinduced structure; 2, that it was distinct from cleavage; 3, that it was not of mechanical origin, but a chemical phænomenon; 4, that it was, perhaps, induced by more than one agency.

On the Occurrence of a True Cretaceous Formation in the South of Africa. By Capt. GARDEN *and* W. H. BAILY, *of the School of Mines.*

Prof. Forbes stated, that the supposed cretaceous rocks discovered in South Africa by Dr. Krauss were really oolitic; but that Capt. Garden had found in Natal an extensive stratum containing truly cretaceous fossils. The species were new, and had been described by Mr. Baily. Figures were exhibited of *Ammonites, Baculites, Inoceramus, Trigonia, Hemiaster*, &c.

On the Geology of India. By G. B. GREENOUGH, *F.R.S., F.G.S.*

The author commenced this Report by observing, that the study of organic remains is the corner-stone of modern geology, and that much more of the history of the earth may be learnt from these than from the nature and properties of inorganic matter. The idea of a definite succession of mineral masses can no longer be maintained; each formation containing its own sandstones, clays and limestones, regularly or irregularly occurring. The same bed changes its mineral character in different countries, or even in the same country, and sometimes in the same quarry. By contact with an igneous or plutonic rock, a sedimentary rock will often be so disguised as to defy recognition. The transformation of lias into Lydian stone, Jurassic limestone into dolomite, chalk into marble, sandstone or clay into jasper, prove how unsafe it is to place implicit reliance on mineralogical character.

The prodigious quantity of plutonic rock, which occupies both the northern and southern portions of India, is not the product of any one, but rather of all epochs; and probably many secondary beds still exist in that country as yet undiscovered. The parts least known are Cashmere and Nepaul, the west coast of Guzerat, and a large area in Orissa and the adjoining country. The following is a very brief abstract of the Report, which was illustrated by a large coloured map of the whole country:—

Post-Tertiary.—Regur, or Cotton Ground, a species of trap-tuff, resembling Nile mud or the black earth of Russia. It spreads over the table-land of the ceded districts and Mysore, and flanks the Neilgherries and Salem hills—covering almost the entire plateau of the Deccan, but has not been observed in the Konkan. It contains no fossils. Kunker, a concretionary substance analogous to the travertin of Italy, filling up fissures and cavities of the beds beneath it. Bones of the Mastodon have been found in it, and the more recent beds contain fragments of pottery. It is used as a rough building stone, and largely in the production of lime.

Gootin, Chunam, a local name for an argillaceous limestone used for building in

Bengal, Behar, Benares, &c., occurs in nodules in the alluvium, which at Calcutta is 500 to 600 feet thick. Near Benares it contains fragments of freshwater shells. South of Madras, a dark clay abounds in marine shells used for lime-burning in preference to the beach shells, as freer from salt.

Laterite, or brick stone, of Buchanan, resembles the trass of the Rhine and the Piperino and Puzzolana of Italy. It extends to Malacca, Siam, Sumatra, Singapore, &c. It caps the loftiest summits of the Eastern and Western Ghauts, and has an average thickness of 100 feet, forming gentle hills or wide terraces, and sometimes spreads out into sheets from a few inches to 250 feet thick, terminating in a mural escarpment, and intersected by valleys which widen like river-courses, and are flat-bottomed. Caverns are not uncommon in this rock. At Travancore are beds of black clay and lignite, 50 and 60 feet thick, in the laterite cliffs.

Pliocene and *Miocene.*—In the salt range of the Punjaub, the uppermost bed contains bones of elephant, horse, ox, great antelope, hyæna, &c., and may be assumed to be a continuation of the Sevalik formation. On the plain between the British territory and Thibet is a boulder-deposit, containing bones of Hippotherium, Rhinoceros, Elephant, and various Ruminants. Bones of the Mastodon and other mammals are found in Perim Id., in the Gulf of Cambay, and in the territory of the Nizam.

Eocene.—The clay of Caribari cliff, N.E. of Bengal, was described by Mr. Colebrook as resembling the London clay, and containing shells, fish palates, and defensive spines, similar to those of Sheppy. Major Fulljames describes a clay with Septaria, like London clay, met with in sinking a well north of Gogo; it was reached at 35 feet, and not passed through at 356 feet. Clay, with shells generically like those of the London basin, has been found on the banks of the Irawadi, in Birmah. Silicified shells were found by Voysey, between two layers of trap in the Deccan. Fragments of chert and argillaceous stone, containing sand and freshwater shells (of the genera *Bulimus, Succinea, Unio, Melania, Limnæa, Physa, Paludina,* and remains of *Cypris* and *Chara,*), are found entangled in the trap, or scattered over its surface, in the Sichel Hills.

Nummulite beds encircle the Persian Gulf, follow the chain of Elborus, and the table-land of Iran; reach the mountains of Caubul, and the Western Himalaya, descend the Solyman chain, and follow that of Hala to the mouth of the Indus; pass again east along the flank of the Himalaya to the confluence of the Ganges and Brahmapootra. They have been traced along 25° or 26° in longitude, from Beloochistan to east of the meridian of Calcutta, and over 12° in latitude from the Runn of Cutch to the north of Cashmere.

Cretaceous.—It would appear that a branch from the main body of the chalk extends from the Taurus to the head of the Persian Gulf. The cretaceous beds of the Deccan were first described by Newbold in 1840. The fossils of Pondicherry were pronounced by Prof. Forbes Neocomian,—those of Verdachellum and Trichinopoli equivalents of the upper greensand and gault. M. D'Orbigny considered the whole Senonian, or of the age of the chalk. The collections include many genera previously considered characteristic of the Tertiaries,—*Cypræa, Oliva, Triton, Pyrula, Nerita,* and numerous species of *Voluta*; and it was inferred by Prof. Forbes that these genera made their appearance earliest in the Eastern seas. Rocks resembling the greensand, and especially the Kentish rag, were observed by Dr. Jack in Sumatra, and soft white chalk with Echini at Bencoolen. Cretaceous beds also occur in Borneo.

Jurassic or *Oolitic System.*—Kelloway rock (Callovien). The representatives of this formation were found in Cutch by Capt. Grant, consisting of slaty clay and calcareous slate, in horizontal beds, forming hills capped with sandstone, containing varieties of *Trigonia costata, Ammonites Herveyi,* &c.

Oolitic coal.—The relative position of the Indian coal has hitherto baffled research, but it may perhaps be classed with the Brora coal. In Cutch it underlies the Kelloway sandstone, and is everywhere intersected with dykes, slips, and other dislocations.

Oxford clay—fuller's earth.—In the part of the Himalaya examined by Capt. Strachey the secondary limestones and shales parallel with the Silurian ridge were several thousand feet in thickness, the upper portion being in some places almost made up of fragments of shells, some of the species resembling forms in the cornbrash and fuller's earth. Above these are soft dark shales, with hard nodules containing

Ammonites and Belemnites of the age of the Oxford clay; the Ammonitic rock probably extended to the eastern part of Nepaul. They occur at an elevation of from 18,000 to 19,000 feet, and are held in superstitious estimation by the natives.

The Oolitic series forms an important element in the rocks of eastern Afghanistan and Northern India. It is known to extend from Cutch on the south along the whole line of hills that flank the Indus, and it forms the scarp of the table-land of Afghanistan as far as the salt range in the upper Punjaub. Oolitic rocks have been observed along the route to Caubul and to the north of that city. North of the great snowy peaks of the Himalaya they follow the southern border of the table-land of Thibet.

In the Rajpootana a number of peculiar marbles occur, of which the Taj Mahal and the palaces of Jodpoor, &c. are built. Amongst these is a *lumachelli* or opaline shell marble, probably of Jurassic age; white, granular marbles are found in the Deccan, and are also metamorphic and of partial occurrence.

Numerous beds of gypsum occur in the Madras Presidency, but their relations are uncertain.

The Diamond Sandstone of Golconda is a more or less compact breccia, red and white, without fossils; its exact age is unknown. Salt springs occasionally break out from the sandstone or its vicinity, With the subjacent limestone, it covers large areas, in almost horizontal layers; but at the edge of the plains of Cuddapah it rises in highly-inclined strata immediately upon granite. Traces of coal are said to exist in the diamond sandstone N.W. of Nagpoor, and abundantly along the valley of the Nerbudda.

Burdwan Coal.—At Burdwan the character of the coal is slaty. The genera of plants are partly English, some Australian, some peculiar. Of the English genera four occur in the coal measures, viz. *Sphenophyllum*, *Poacites*, *Calamites*, and *Pecopteris.*

Jurassic of Deccan.—It has been ascertained by Messrs. Hislop and Hunter that the great trap deposit of the Western Ghauts rests on a sandstone, with vegetable remains, chiefly ferns, *Pecopteris*, *Cyclopteris*, *Sphenopteris*, *Equisetites*, many species of *Glossopteris*, and the *Vertebraria Indica*, which also characterizes the Burdwan beds. At Godavery was found the *Lepidotus Deccanensis* referred by Sir P. Egerton to the lower oolite or lias.

Trias.—New Red Sandstone—Red marl. The sandstone of the Bandair hills and Sagar is referred to this formation. According to Mr. James Hardie, the New Red with salt may be traced through the Baralpur northward through Delhi, and there connected with the salt and gypsum-bearing rocks in Lahore, Moultan, &c., southwards towards Cutch, perhaps to Persia, forming a zone round the great elevated formation of Central India, and separating it from the primary. Muschelkalk has been observed by Capt. Strachey, north of the valley of Niti, Himalaya. The fossils resemble those of St. Cassian, but the species are all distinct. Twenty-five species were collected, belonging to the genera *Ceratites*, *Goniatites*, *Ammonites*, *Spirifera*, *Terebratula*, *Chonetes* (?), *Pecten*, *Pholadomya.*

Carboniferous Limestone.—Organic remains collected by Dr. Fleming in the limestone near the bottom of the escarpment of the salt range, Himalaya, include *Producta cora* and *Athyris Roysii.*

Devonian? Kala or salt range.—The chief supply of salt is derived from the range between the Jhelum and the Indus. According to Dr. Andrew Fleming, the gypseous red marl, with rock salt, lies at the very base of the section, beneath the bituminous shale, with lignites and carboniferous limestone; and he assigns it a place among the Devonian rocks. However, less pure rock-salt and salt springs occur in the outer ranges of the Himalaya, in what are believed to be Eocene strata. The bituminous shales abound in iron pyrites, from which alum is prepared exactly as at Whitby; the manufacture has been carried on by the ancestors of those now engaged in it for eight generations. No fossils have been found in the saliferous beds of the Punjaub.

Silurian.—The higher regions of the Himalaya afford many forms of Trilobites, Mollusca and Zoophytes, characteristic of the Silurian period, very similar to those of Europe; not one, perhaps, specifically identical with them.

On Crustacean Impressions from the Trias of Dumfries-shire. *By* Professor HARKNESS, *F.G.S.*

It was well known that footprints of reptiles were abundant in the New Red Sandstone of Dumfries. Those now exhibited were compared to leech-bites in form, and were believed to be left by crustaceans. They came from an upper bed of sandstone, quarried at Corse Hill, north of Annan. The layers were sometimes ripple-marked and channeled as if by rills of fresh water trickling over a shore.

On the Anthracite Deposits and Vegetable Remains occurring in the Lower Silurians of the South of Scotland. *By* Prof. HARKNESS, *F.G.S.*

These strata form the high land south of the Firths of Forth and Clyde, and have a general inclination to the N.N.W. The highest beds are on the northern side of the range; and consist, near Girvan, of limestone and sandstone, with fossils of the Llandeilo rocks. To the southward, fossils are rare; but near the lowest part of the series, at Glenkiln, nine miles from Dumfries, organic remains are found in beds of anthracite, resting on 1500 feet of unfossiliferous purple and grey sandstones and shales. The fossils are *Graptolites sagittarius*, *Diplograpsus pristis*, and *D. ramosus*; *Siphonotreta micula* occurs with the Graptolites in a thin bed of black shale at the base of the anthracitic beds. At Duff-Kinnel, crustaceans of the genus *Dithyrocaris* have been found. These fossils do not account for the carbonaceous matter in the black shales, but indications of "fucoids" have been found; and it is supposed that much of the hydrocarbon of these beds has been lost through the influence of mechanical forces. Fucoids of the genera *Palæochorda* and *Chondrites* are found in the ripple-marked flags of a much higher part of the series, north of New Galloway, unaccompanied by anthracite, but associated with a zoophyte (*Proto-virgularia*) and tracks of Annelids. The anthracitic beds were supposed to have derived their carbonaceous matter from sea-weeds floating like the gulf-weed of the present day.

On Mineral Charcoal. *By* Professor HARKNESS, *F.G.S.*

This substance occurs in the form of a black pulverulent silky-looking substance, or a granular powder, in almost all descriptions of coal, but is most abundant in those beds which appear to have resulted partially from drifting. This appears to have been the case in Nova Scotia as well as in Great Britain. At Sanquhar, the culmstone coal, which has a roof of fine indurated clay, indicating tranquil water, contains little mineral charcoal, whilst in the "Creepy coal," which has a flaggy roof, the charcoal is abundant. Microscopically examined, the charcoal appears to consist of cellular or glandular tissues; the fibrous parts especially resemble the texture of the Calamodendra of the Lancashire coal-measures.

On Annelid Tracks from the Representatives of the Millstone Grits in the County of Clare. *By* Professor HARKNESS, *F.G.S.*

The peculiar markings regarded by the author as tracks of Annelids are best developed in the certain greenish grey flags which occur at Kilrush and Kilkee, north of the Shannon. They have the form of meandering tracks, half an inch across, with crenated margins and a central line, with cross-lines between, apparently indicating the segments of the body and organs of locomotion. In the dark-coloured flags below, the tracks are sinuous, but rarely crenated, and occur on the laminæ as well as on the surfaces, and look like filled-up burrows of marine worms, and sometimes terminate upwards at funnel-shaped depressions.

Abstract of Paper explanatory of a Geological Section, extending from the Island of Little Eye across the Peninsula between the Estuaries of the Dee and Mersey to the East of Liverpool. *By* EDWARD HULL, *F.G.S., of the Geological Survey of Great Britain.*

After describing the section, which was plotted to a natural scale, extending more than 11 miles at 8 inches to the mile, with a datum line of 1000 feet below the level of high-water mark, Mr. Hull went on to remark that the new red sandstone from the base of the red marls downwards consisted in this neighbourhood of four well-marked subdivisions, which are arranged under the following heads:—

1st. Waterstones.
2nd. Upper soft red and variegated sandstone.
3rd. Coarse red sandstone and conglomerate.
4th. Lower soft red and variegated sandstone.

It has been demonstrated by the work of the Government Geological Surveyors, that these four subdivisions are constant along the borders of Wales, from the Mersey to the Malverns, and extend thence into the central districts, where, though one or more of the subdivisions are occasionally absent, yet the strata which do occur always present lithological characters by means of which they can be arranged under either of these subdivisions. Through the knowledge obtained from this classification, nearly all the faults affecting the trias, of which there are a great abundance, have been laid down on the maps of the Geological Survey, and their amount of dislocation can generally be calculated. On the section, nine faults, the directions of which approximated due north and south, were drawn; and their amount of down-throw, varying from 1050 feet to 80 feet, was marked; and the total thickness of the new red sandstone from the base of the marls was stated to be from 1400 to 1500 feet, in the district between Liverpool and Chester. In the border counties, the New Red (Bunter) attains its maximum thickness. In the shires of Nottingham, Derby, Stafford and Leicester, the 2nd and 4th members of the series are very thin, or entirely absent; and the whole formation is represented by the 2nd member, under the form of coarse pebbly sandstone or quartzose conglomerate, from 100 to 200 feet thick.

It was shown that the Conglomerate beds and Waterstones form two conglomeritic and often calcareous horizons; and that from the base of the Waterstones downwards, the New Red Sandstone might be considered as a great deposit of soft variegated sand without pebbles, separated into two nearly equal portions by sandstones of a harder quality, coarser grain, and generally conglomeritic; the whole presenting four æras in the history of the New Red Sandstone in England, during which similar physical conditions of sea and land maintained at alternate periods.

In application of the work executed by the Geological Survey in the New Red Sandstone districts to practical purposes, Mr. Hull stated that we are now able to tell the depth below the surface to which the base of the New Red extends, so that we were made acquainted with those localities where (*cæteris paribus*) there was the greatest probability of finding coal at moderate depths. Observations were then made concerning the favourable and unfavourable circumstances to be taken into consideration, where borings for coal were proposed in areas occupied by the New Red Sandstone, and the modifications produced by the probable presence or absence of Permian and upper Coal Measures, while the absolute necessity of having an accurate knowledge of the arrangement of the strata around areas occupied by productive Coal Measures, in order to success in any such undertaking, was strongly urged.

The One-Inch Map of the Northern Part of the County Wicklow, geologically coloured. By J. B. Jukes, *F.R.S., F.G.S.*

Mr. Jukes stated that the data were all laid down on the great six-inch map, and preserved as public documents. He recommended the adoption of shades of lake for the felspathic rocks, and green for the hornblendic series.

Mr. S. Knipe exhibited several sections in the neighbourhood of Liverpool.

General Observations on the Palæozoic Rocks of Germany.
By Sir Roderick Impey Murchison, *D.C.L., F.R.S. &c.*

This communication by Sir R. Murchison was stated to be the general outline of a detailed memoir to be offered by Prof. J. Morris and himself to the Geological

Society of London; his chief object being to extend the fourteenth chapter of his recently published work 'Siluria,' on the Primeval Succession in Germany.

To render his views clear, he exhibited a large tabular view in which the order of superposition of all the sedimentary rocks of Germany was given, from the lowest known 'grauwacke,' in which no fossils have been detected, through an ascending series of Silurian, Devonian, Carboniferous and Permian rocks; the latter overlaid by the Trias or lowest group of the mesozoic or secondary rocks.

Referring to Barrande's remarkable work, the 'Bassin Silurien de Bohême,' he first sketched briefly how a vast pile of unfossiliferous schistose rocks was succeeded near Prague by what that author termed his 'Zone Primordiale,' with its Trilobites, Cystideæ and Orthidæ (the equivalent of the Lingula flags of North Wales or basement Silurian rocks of the Geological Surveyors of Britain), and how that was followed by an enormous mass of schists, coarse grits and quartzites, referred by Barrande from its fossils to the age of the great mass of Lower Silurian (Llandeilo and Caradoc), as originally published in the 'Silurian System.'

The only characteristic representatives of the Upper Silurian known in Germany occur in this district of Bohemia, where a considerable thickness of shale and mounted by limestones, represent the Wenlock and Ludlow formation of Britain. Several, however, of the species which in England are typical of the one and the other of these rocks, occur in the same Bohemian bed; *i. e.* Ludlow rock forms are mixed up with others in a stratum occupying the place of our Wenlock shale.

In the Southern Thüringerwald and in the parts of Saxony to the east of it, the ascending order from a great unfossiliferous base (chloritic and quartzose grauwacke slate) is succeeded by the Lower Silurian, described as such by Geinitz, Richter, Engelhardt and other native geologists, because it is charged with Nereites, Graptolites and Trilobites, including *Ogygia Buchii*, with Trinuclei, Orthides and other Silurian fossils which occur in black slate with some limestones and shale. With the fossils enumerated the ascending series stops; there being no trace of Upper Silurian. The Lower Silurian slates are there at once covered transgressively by the Devonian, and chiefly by the Cypridina schists and Clymenia limestone (Kramenzel stein of the Rhine). The latter rocks contain a remarkable number of plants, discovered by M. Richter, of very peculiar forms, and which are about to be described by Prof. Unger. They are surmounted by a considerable expansion of the Lower Carboniferous strata, viz. micaceous, brown and yellowish sandstones, with plants well known in deposits of that age. Near Hof this group contains limestones with Producti of species known in Britain and France, as formerly pointed out by Prof. Sedgwick and the author.

The Devonian and Lower Carboniferous rocks have been subjected to the same undulations, and are perfectly conformable to each other, and in the southernmost extremity of the Thüringerwald are seen to be abruptly separated from the coal-fields "*Steinkohlen Gebirge*," composed of grey sandstone and schist, which, charged with numerous common coal plants, are often worked, to a small extent, under a very great thickness of the Rothe-todte liegende, or Lower Red Sandstone of England.

The Harz Mountains are entirely deficient in the unfossiliferous bottom rocks of Bohemia and the Thüringerwald, and also of the great development of Lower Silurian exhibited in each of those chains. The sedimentary rocks of the Harz which Prof. Sedgwick and the author examined together on two former occasions, first in the year 1828, and afterwards in 1839, are so dislocated, and so often inverted in position, as explained in a former communication, that their true physical order is rarely to be detected amid the confusion which has been produced by the eruption of granites, porphyries, diorites, hypersthene and other igneous rocks, as well as by the metamorphism which large masses have undergone; the schists and slates having been often converted into massive "hornstone" around the chief masses of granite.

The author, however, expressed his belief, that all the members of the Devonian group, or Rhenish grauwacke of the Germans, from the Spirifer sandstone and slates upwards through the Wissenbach slates and Eifel limestone, to the Upper or Clymenia limestone, are there present, and that these are succeeded by some schists often in the slate of Kiesel Schiefer, by others containing the well-known *Posidonomya Becheri*; whilst in one tract rocks of this Lower Carboniferous age consist of a dark limestone with characteristic fossils of carboniferous age. The comparison which has been worked out in some detail by M. Adolphe Römer, who is still occupied in that labour and in completing a map of this highly complicated tract, was in a general sense approved of. But in a future communication, the author and his companion Prof. Morris, will endeavour to show, in relation to one of the opinions of M. Römer, that in reality all the strata in the Harz, including the Wissenbach slates, may be found to occupy the same relative position as in the region of the Rhine. The chief object of Sir R. Murchison in revisiting the Harz region was to determine if certain rocks in its eastern extremity, which have been laid down and mapped as Silurian by M. Adolphe Römer, are really of that age: he reminded his auditors that it was just in this tract that Prof. Sedgwick and the author himself anticipated fifteen years ago that the oldest rocks of the chain would be found. The discovery of the fossils which decide the case is due to M. Jasche of Elsinburg, and M. Bischof of Mägdesprung. In one small boss of limestone (not exceeding 10 feet in thickness) and subordinate to the slates on the N.E. flank of the mountains, the former has discovered fossils of the genera *Orthis*, *Terebratula*, *Leptæna*, *Spirifer*, *Pentamerus*, *Trilobites*, &c., few of which are British species, though others more numerous are identified with Bohemian fossils described by Barrande from his uppermost Silurian stages. At Mägdesprung the limestone subordinate to a great thickness of greywacke schist and flagstone was formerly alluded to by Prof. Sedgwick and the author, who in their hurried visit detected no organic remains except Encrinites, though they were aware that Trilobites had been found there many years ago by M. Zincken. Looking to the mineral aspect of these schists and limestones which differ from any others in the Harz, and judging from the fossils, the greater number of which are of types more ancient than those of any known Devonian rock, the author believes that the grauwacke around Harzgerode, in which limestones protrude at several other places besides, may be referred to the uppermost Silurian, and placed on the same level as one of the highest stages of M. Barrande. The flagstones of this uppermost Silurian grauwacke, which has much the aspect of the Arbroath paving-stones of Forfarshire, are remarkable in containing a Calamite or Knorria, which is the largest plant ever seen by the author in rocks of such high antiquity.

In the Rhenish country it was found that the Wissenbach and Caub slates had been perfectly identified by the brothers Sandberger through a community of fossils, and that Clymeniæ had been found in the Cypridina schists of Nassau; thus identifying these rocks with the Kramenzel-stein of Westphalia. The most striking new discovery in this region is one with which the author was unacquainted when he published his recent work, viz. that the quartz rocks of the Taunus, about whose place in the series so much discussion has taken place, are now found to be the youngest of all the rocks on the right bank of the Rhine. In their trend to the E.S.E. they part with their highly metamorphosed character, and being regularly bedded and interlaminated with shale, have there been shown by M. Ludwig of Nauheim (in maps and sections) to overlie the series of Rhenish Devonian rocks, consisting of ascending order of slates, Spirifer sandstone, Wissenbach slates, Eifel limestone, &c. In these overlying quartzites large plants like Calamites have been discovered, and as they lie transgressively upon the Devonian rocks, they are considered to be of the Lower Carboniferous age.

Of the Permian rocks around the Harz and Thüringerwald, Sir Roderick then gave an account, in which he pointed specially to the enormous thickness of their base, *i. e.* the Rothe-todte liegende (the Lower Red Sandstone of England). He corrected the error of supposing that any appreciable amount of coal occurs in this deposit; the mineral as found at Wettin, Ilmenau and other places being in a grey and totally distinct matrix, entirely beneath all the red rocks; though rare and partial, thin courses of coal are seen in one of the divisions of the "Rothe-todte liegende," the chief of which, in Saxony, has afforded the remarkable Permian Flora, described as such by Gutbier and Geinetz in their 'Permische System in Sachsen.' On the other hand, at Rotheberg, near Eisenach, these red rocks have been pierced to a depth of about 1200 feet without offering a trace of coal, and at Eisenach a boring commenced at 800 feet beneath their conglomerate summits, has been made to the depth of 2000 feet more, the whole in this Lower Red Sandstone, without reaching the Carboniferous series.

The characteristic plants of this rock, as seen at Kifhauser and Eisenach, are silicified Psaronites. The uppermost beds of the Rothe-todte, of a greyish and light colour ("grau liegende" and "weiss liegende"), are exposed in natural sections on the N.E. flank of the Thüringerwald, where they are surmounted by bituminous schists and the Kupfer Schiefer with its fossil fishes.

The Zechstein offers in its details all those mineral and zoological distinctions which have been pointed out in the works of Sedgwick and King, the one on the Magnesian Limestone, the other on the Permian fossils of England; the principal distinction in Germany consisting of enormous interpolated masses of gypsum. Sir Roderick then explained why, in proposing the word Permian, he had further included in this group a certain portion of schistose and partly calcareous red rocks which everywhere overlie the Zechstein or Magnesian limestone, and often constitute ridges separated from the "Bunter Sandstein," properly so called, or base of the Trias. In this way he considered the Permian (which in Russia, whence he derived the name, has mottled copper sandstones with plants and conglomerates far above the Zechstein) to be an under Trias; the Zechstein limestone being placed between two red formations.

Though only indirectly connected with the object of this communication, the tabular view exhibited the chief divisions of the true German Trias or base of the secondary rocks with its profusion of large Saurians; attention being specially called to the *entire change of animal life* in passing from the Permian or uppermost Palæozoic into this lowest Mesozoic or secondary rock, though the one was perfectly conformable to the other: in other words, he demonstrated how, in the long lapse of time, the primeval creatures had dwindled away and finally expired, to be succeeded by entirely new creations.

In the course of this exposition Sir Roderick also called particular attention to the recently published geological map of the Thüringerwald by M. Credner, in which many minute lithological distinctions are marked, and everything connected with the order of the rocks above the coal, and all the stages of the secondary rocks, most correctly inserted. The only desideratum is that the German author should apply thereto the distinctions of Azoic, Silurian, Devonian and Lower Carboniferous; all of which natural divisions are included in his older and younger 'Grauwacke.'

In speaking generally of the Carboniferous rocks of the Continent, Sir Roderick exposed to the Section new plates of a work by the able Belgian palæontologist, M. de Koninck, illustrating all the forms of shells which have recently been discovered in the Carboniferous limestone and shale at Bleiberg in the Carinthian Alps. He alluded to the circumstance of Prof. Sedgwick and himself having, twenty-five years ago, first mentioned some striking species of large Producti well known in Britain, which they found in that locality; but the Belgian Professor has much augmented the list in the work about to be published at Vienna, which records the remarkable fact that out of seventy-five species twenty-five only are new, the remainder, or fifty, being forms identically similar with those of the same age in Belgium, France, Britain and America; thus proving the very wide if not universal diffusion of these ancient marine animals.

It was further stated, that Hermann von Meyer has collected materials to prove that the Archegosaurus of the coal of Saarbruck is as true a Labyrinthodont Saurian as any one of the Trias. Sir Roderick also adverted to a very curious discovery of a richly fossiliferous mass of white and pink muschelkalk to the north of Halle by M. Giebel, which Prof. Morris and himself visited with that palæontologist, and which, besides characteristic shells of the Muschelkalk, contains forms never before seen in that formation.

In commenting upon the spread of the Trias through Europe, the author specially called attention to a letter just received from M. de Verneuil, announcing the discovery of true Muschelkalk in several parts of Spain, accompanied by numerous fossils.

The communication terminated with a general *résumé*, in which the author particularly directed attention to a roughly coloured map of Germany in which he had inserted the main direction of the Palæozoic rocks of the Rhenish Provinces, Saxony and Bohemia, as being the prevalent strike from N.E. to S.W., whilst in the Harz, N. Thüringerwald and the Riesengebirge, deposits of the same age, *i. e.* from Silurian to Lower Carboniferous inclusive, had been wrenched into a transverse or N.W.

and S.E. direction, accompanied by extraordinary metamorphism occasioned by the intrusion of granites, porphyries, and other eruptive agents.

Sir R. I. **Murchison** exhibited a slab of Old Red Sandstone, sent by his old friend and coadjutor the Rev. T. T. Lewis, the chief contributor to the elucidation of Siluria, who had lately discovered rippled surfaces and trails of animals in the Old Red Sandstone of Puddlestone, near Leominster. The tracks were of two kinds, one set perhaps produced by a mollusc, the other by a crustacean.

On the Structure of Lunar Volcanic Craters.

By JAMES NASMYTH, *F.R.A.S.*

This communication was illustrated by a model of the lunar volcano Copernicus and a diagram of Simpelius; each of which consists of a plateau, with central cones surrounded by a ring-shaped elevation, exhibiting concentric ridges or terraces. The circular elevations were supposed to have been formed by the accumulation of materials erupted with great energy to various distances, according to the intensity of the force; giving rise to concentric ridges, or *terraces of deposition*, which are often nearly entire circles, one within the other. Besides these, there are other terraces, forming only segments of circles, within the principal rings, which were attributed to the agency of landslips: these in most instances correspond to notches in the edge of the crater, from which they have slipped, and their débris has rolled over the plateau, towards the centre. The central cone was attributed to the last expiring efforts of the eruptive action.

In the discussion which followed the reading of his paper on the above subject, Mr. Nasmyth took occasion to state as the result of a very long course of most careful observations and mature reflection thereon, that he is convinced and satisfied that no *active* volcanic action exists *now* on the surface of the moon; that he considers volcanic action to result from the forcing up through the cooled and consolidated surface of a planet of some portion of the yet remaining molten matter of which all planets in their normal condition consisted; that as the mass of the moon is only about $\frac{1}{82}$nd part of that of the earth, while its surface is the $\frac{1}{13}$th; and as the comparative rate at which such masses in planets cool down from an original molten condition is in the relative ratio of their mass divided by their surface, the moon must have become a cooled and consolidated planet ages sooner than the earth, and its active volcanic æra have terminated proportionably sooner; that for these reasons he considers volcanic action as an expiring phænomenon, and that in the lapse of time all active-volcanoes will cease on the earth, as he is satisfied they have long since done in the moon.

On the Subdivisions of the Palæozoic Rocks of Scotland. By D. PAGE.

Mr. Page commenced by remarking the present undetermined superposition and relations of these strata, and the frequency of such allusions in published works as, that the "older rocks of Scotland seem to belong to the Lower Silurian;" "the old red sandstone and carboniferous system appear to graduate into each other;" and more recently still, "the carboniferous rocks of Scotland admit of no subdivision." Such statements, he thought, must arise either from the limited observations of the writers, or from their acquaintance only with the published descriptions of Scottish rocks, as given to the world twenty or thirty years ago. Having directed attention to several sections taken across the Scottish basin, from the Grampians on the north to the Lammermuir on the south, he passed over the lower slates and old greywacke grits, which were yet imperfectly determined—and which he would reserve for another occasion—and commenced his proposed subdivisions with such strata of the old red sandstone, or Devonian rocks, which contained remains of fishes. By taking this starting-point, or basis, and which was the same as that advocated in Sir Roderick Murchison's recent work 'Siluria,' he cut off a considerable portion of strata hitherto classed with the old red sandstone, believing they would yet be found to belong to Silurian strata, as would also be other underlying schists hitherto classed with the Clay-slate system. The old red sandstone, as thus based, was subdivisible into *three* great groups, which, in the absence of better terms, he would designate, "Lower or grey group," the "Middle or red group," and the "Upper or yellow group." The grey group consisted of laminated flagstones and rusty-coloured sandstones, with occasional beds of carbonaceous shales. The second group consisted of red and chocolate-coloured sandstones and conglomerates, with beds of cornstone or concretionary limestones; and the upper group of thick-bedded yellow sandstones and variegated marls. The lower and middle groups were typically developed in Forfar and Fife, the upper group especially in Fifeshire. In some of the conglomerates (which were simply consolidated gravel and shingle) there were, he thought, evidences of "ice drift" in the smoothed and scratched boulders, particularly in their peculiar aggregation, which was strictly analogous to the piling up of shingle and gravel and clays on the Arctic shores, as described by Deas and other Arctic voyagers. Palæontologically, the lower or grey group was characterized by abundant terrestrial vegetation, by ichthyolites, as the Cheiracanthus, Osteolepis and other spiny-finned fishes described by Prof. Agassiz, and by crustacean remains, as those of the Pterygotus and other undescribed sessile-eyed genera. The red group was entirely void of vegetables, and characterized more especially by the Cephalaspis, Coccosteus and other bony-cased fishes; and the upper or yellow group by such fishes as the Holoptychius, Platygnathus, and other ordinary finned fishes. With regard to the carboniferous system, as developed in Scotland, he proposed to divide it into three or four great groups:—1st, "The lower coal-measures;" 2nd, "The mountain limestone;" 3rd, "The millstone grit;" and, 4th, "The upper or true coal-measures." The lower group, mineralogically speaking, consisted of thick white bedded sandstone (Craigleith and St. Andrew's) beds of fire-clay, shale, thin seams of coal, and peculiar beds of freshwater or estuary limestones —this limestone being thick and compact as at Burdiehouse and Burntisland; or thin, and entirely composed of shells, as in the east of Fifeshire. The mountain limestone, though not so fully developed as in Derbyshire and Yorkshire, was yet characterized by the same marine fossils, viz. corals, testacea, and fishes. The millstone grit was very imperfectly developed; but the true or upper coal-measures were fully developed, and consisted of frequent alternations of sandstones, fire-clays, shales, coals, ironstones, and impure limestones not containing encrinites or marine fossils. Palæontologically speaking, the lower group was well marked off by the marine beds of the yellow sandstone beneath, and the mountain marine limestone above. Its organizations were more of an estuary character, and, though containing many of the same vegetables as the true coal-measures, he thought they indicated frequent specific distinctions. The mountain limestone was also well defined, whether in its shales or limestones—its organisms being strictly marine in character, and not to be mistaken; namely, corals, encrinites, shells of the Productus, Terebratulæ, Spirifer, &c., and occasional Trilobites. The millstone grit and upper coal-measures, though containing bands of mussel-like shells and teeth of the Megalichthys, were principally characterized by those Sigillaria, Stigmariæ, Tree-ferns, Calamites, and other plants which mark all true coal-fields. Restricting himself to the series above described, he avoided the consideration of some upper sandstones, &c., which appeared to belong to the Permian; he would propose for Scotland, at least, the following subdivision of the old red sandstone and carboniferous systems:—*Carboniferous*: 1. upper coal measure; 2. mountain limestone; 3. millstone grit; 4. lower coal-measures. *Devonian*: Upper yellow group; middle, or red group; lower, or grey group. Adopting the maxim that the fullest development of strata should be taken as the typical classification, Mr. Page concluded his exposition by suggesting the adoption of the "Yellow group" of the old red sandstone and the "Lower coal-measures" into the published classifications of British deposits.

On the Structure and Texture of Stratified Rocks, as a means of determining the Conditions under which they are formed. By D. PAGE.

Mr. PEACH exhibited specimens of Old Red Sandstone, containing bitumen and silicified wood (?), from Gallows Hill, near Thurso, and others from the dark flagstones of Wick, Caithness; also examples of the Wick flagstone, containing layers of broken and compressed shells (?) larger than the "Cyclas" found by Mr. Dick at Thurso.

Mr. J. Price invited attention to the geology of a little district, of carboniferous limestone, at Llysfaen and Penmaen Rhos, near Abergele. The drift here assumed four distinct appearances:—1st, flattish boulders of micaceous sandstone, with Terebratulæ, were strewn over the surface of the elevated sheep pastures; 2nd, the slopes towards the sea were thickly covered with drift, composed of native limestone in a semi-bouldered state, often scored with parallel lines, the fragments being sometimes 18 inches across; 3rd, drift of very smooth pebbles of limestone, in a matrix of highly comminuted lime gravel; 4th, a gravel pit at Tyn-y-coed contained pure sea-sand and gravel of small pebbles like the present beach: one of the pebbles had been perforated by the Cliona. There were also lumps of clay stuck over with pebbles. This spot was now three-quarters of a mile inland, and 300 or 400 feet above the sea level.

On the former probable existence of Palæozoic Glaciers.
By Professor A. C. Ramsay, *F.R.S.*

Admitting the probability that the earth may have cooled down from a molten condition, the author is of opinion that no trace of that refrigeration can be detected (as regards the climates of the globe) since the formation of the oldest fossiliferous strata; or, in other words, the internal heat of the planet has not by radiation exercised a climatal influence within any of the known geological periods. The Silurian fauna is not essentially tropical in its characters. The Coal-measure flora, once considered tropical, has more lately been pronounced by Dr. Hooker indicative of a moist, equable, and probably a temperate climate; and if the Ammonites, Nautili, and reptiles of the Oolitic and Cretaceous epochs in these latitudes really lived in warmer seas than ours, the circumstance must be referred to changes in physical geography rather than to any direct climatal effects produced by internal heat. He then proceeded to show evidence that glaciers and icebergs had existed in these latitudes during a part of the Permian epoch, and that also in the secondary rocks there were probable traces of the same actions in some of the beds of the Bunter sandstone.

Where the Permian rocks are best developed in the central counties of England, they consist of interstratifications of red marls and calcareous sandstones, in the higher part of which, near Enville, are two beds of calcareous conglomerate. About 200 feet above the highest of these is a mass of trapoid breccia, which is again succeeded by marls and sandstones. Excepting a fragment of the stem of a tree found by the Geological Survey in the calcareous conglomerate, no Permian fossils have been found in these rocks in the areas referred to in this notice. Above the Permian rocks the Bunter sandstone has been divided as follows:—

5. White and brown sandstones with interstratification of marl.
4. Upper variegated sandstone (mostly brick red).
3. Coarse sandstone, conglomerate, and pebble beds.
2. Lower variegated sandstone (mostly brick red*).
1. Permian.

The trappoid breccias † occur on the flanks and summits of parts of the Malvern and Abberley range, where they rest directly on the Silurian strata. On the banks of the Severn near Stourport and Bewdley, Worcestershire, and in an isolated patch about five miles west of Bewdley, they lie upon the coal-measures; in the neighbourhood of Enville, Worcestershire, they occur near the top of the Permian strata, and they form the highest exposed Permian beds at the southern end of the South Staffordshire coal-field, where they constitute the range extending from Clent Hills to the Bromsgrove-Lickey, &c. They vary in thickness from about 100 to 300 feet according to locality.

The fragments found in the breccia are not derived from the Permian beds lower in the series on which it rests in South Staffordshire and near Enville, nor yet from the Coal-measures, Old Red Sandstone, and Silurian strata on which it lies in the Malvern, Abberley, and Bewdley districts; nor is it probable, taking the physical structure of the country into account, that they were formed from the waste of rocks now concealed beneath the upper and lower New Red Sandstones of these or of neighbouring areas. In lithological structure they can generally be identified with the Cambrian rocks of the Longmynds, and the Lower Silurian slates and igneous rocks, &c., that overlie these between the Stiper stones and Chirbury in Montgomeryshire. They are enclosed in a hardened paste of fine red marl, probably analogous to the boulder clay of Pleistocene deposits. The included fragments and blocks consist of greenstone, felstone, felstone porphyry, felspathic ash, hard ribboned slate, such as occurs north of Shelve, quartz rock, purple and green sandstone and slate, black slate, and sandstones and limestones containing Silurian fossils. Very few of the stones are well-rounded. Many of them are angular, most of them are subangular, and have those flattened surfaces common in fragments found in moraines. They are frequently well-polished and occasionally scratched. They are of all sizes up to 4 feet in diameter. If they came from the Longmynd district, in places they have travelled at least fifty miles, and there is evidence from the outcrops that even now in their fragmentary state they occupy an area of from twenty-five to thirty-five miles in diameter, while there is perhaps much more concealed beneath the surface. Had they formed sea beaches they would probably have been rounded by the waves, and there is nowhere any sound proof that they were scattered abroad by great marine floods. Blocks 2 feet and more in diameter are not moved along sea bottoms by tidal currents; and considering their size, angularity, polish, occasional scratchings in straight and sometimes parallel lines, and also the matrix that encloses them, the author believes that they were deposited from icebergs, derived from glaciers that rose in the ancient land of the Longmynds and the overlying Lower Silurian strata. The Longmynds are now only 1900 feet above the sea, but on their eastern side between the mountains and the breccias, there is in the great Church Stretton fault a downthrow on the west of about 1500 feet. This fault is at least, in part, and perhaps altogether, of later date than the New Red Sandstone, so that the relative levels of the Longmynd rocks and of the breccias were not the same as at present when the latter were deposited.

---

* This order of superposition has lately been established by Mr. E. Hull.

† Adopted from Prof. Phillips' nomenclature. See his work in the 'Memoirs of the Geological Survey of Great Britain,' vol. ii. part 1.

Traces of a similar glacial action occur in the Bunter sandstone on two horizons; first in a part of the pebble beds near Bewdley (No. 3), and later at the base of the white and brown sandstones (No. 5) between Stourport and the Abberleys.

The author has elsewhere shown that the Longmynd and Shelve rocks were once covered unconformably by more than 3000 feet of Upper Silurian rocks, and probably also by a great thickness of Old Red Sandstone. If the previous reasoning be correct, we get a date for the denudation of these strata which must have been removed before the epoch of the Permian glaciers.

It may hereafter appear that the phænomena above described are connected with the paucity of organic remains in a large part of our Permian strata and in part of the Bunter sandstone.

On the thickness of the Ice of the Ancient Glaciers of North Wales, and other points bearing on the Glaciation of the Country. By Professor A. C. RAMSAY, *F.R.S.*

The principal object of this paper was to prove that the ice of the greater glaciers of North Wales was about 1300 feet thick; that the valleys of Llanberis, Nant-Francon, &c., were in fact partly filled with ice at least of that thickness. This was inferred by observations analogous to those by which it has been shown that the ice of the Swiss glaciers was formerly of much greater thickness than at present. The observations were made with Adie's sympiesometer. The directions of the grooves and scratchings were carefully mapped by compass, and their heights above the bottom of the valleys determined. The author has previously shown in a paper in the Journal of the Geological Society, that there were two sets of glaciers in North Wales since the ground assumed its present general form. The first was on a large scale, and it was probably at this epoch that the ice attained its greatest thickness, perhaps at the very time when the Swiss and Himalayan glaciers were on a much grander scale than at present. At this period, in Wales, the glaciers, as proved by the groovings, passed *straight across the tributary valleys* of the Pass of Llanberis to a height of about 1300 feet above the bottom of the main valley. Similar phænomena were observed in Nant-Francon and elsewhere in Wales. In the case of the Pass of Llanberis the ice and snow must have been more than 600 feet thick *at the top of the Pass* to give the necessary inclination for the flow of the ice down the valley, for the lowest watershed at the top of the Pass is only about 1000 feet above the sea level, whereas the highest parallel groovings that follow the course of the main valley further down are about 1600 feet above the level of the sea. The country was subsequently depressed to a depth of about 2300 feet, the cold still continuing, and glaciers on a smaller scale passed out to sea, and round the coasts *marine moraines* were deposited. Further out at sea, on Moel Tryfan and in other places, marine deposits with shells were formed either contemporaneously with these marine moraines, or during subsequent oscillations of level by the re-arrangement of the moraine matter.

During the last emergence of the land the moraine-drift was cleared out of several of the greater valleys by the second set of large glaciers (Nant-Francon, Llanberis), but in others the drift still remains damming up many of the mountain lakes. These latter glaciers gradually decreased in size, evidence of which may be found in the moraines that occur in the valleys at different levels. In Cwm Glas in the Pass of Llanberis, there are several left by a retiring glacier, some of them arranged concentrically one within another, and this glacier finally disappeared in the highest recesses of the valley immediately north of the ridge of Crib-goch. The groovings made by these later glaciers often pass *across* those made by the greater preceding glaciers. Their moraines frequently form the dams of lakes, and the *roches moutonnés* of the country are often strewed with *roches perchés* which they have left. In the higher parts of the minor valleys the grooves converge towards the hollows, in the manner that might be expected from the ice pressing or flowing downwards to feed the main icy streams.

The Island of Anglesea in many places exhibits the effects of ice. Large tracts are rounded, smoothed, polished, grooved and scratched, and in spite of the roughness produced by subsequent waste, the general form of the ground gives the idea of its having been moulded by ice. The groovings generally run from 25° to 30° north of east, passing along the sides and apparently over hills several hundred feet high. The direction of these furrows seems to have no connexion with the mountain glaciers of the Snowdon range. It has been customary to refer these and similar markings in the low lands to the drifting of icebergs. This solution does not appear altogether satisfactory.

On the May Hill Sandstone, and the Palæozoic System of England. By the Rev. Professor ADAM SEDGWICK, *F.R.S., F.G.S.*[*]

The Rev. W. SYMONDS exhibited some fossil remains of fishes from the Old Red Sandstone of Herefordshire and the carboniferous limestone of Tortworth.

On the Silurian Anthracite of Cavan, discovered by Professor JOHN IRWINE WHITTY, *LL.D., of Dublin, Mining and Civil Engineer, Professor of Geology to the Dublin Chemical Society.*

Professor Whitty stated that the rock in the district about Kilnaleck where the culm was discovered belongs to the Lower Palæozoic formation, and not to the true coal formation; and that a bed of soft anthracite occurs there about 4 feet in thickness, in a dark grey clay-slate, having the same strike and dip as the accompanying rocks. The strike is about 37° east of north by the true meridian, and the dip south-eastwards 85°. He described minutely the rocks of the locality, and stated that a bed of culm has been found in Scotland, in graywacke also, which he supposes to be a continuation of the formation in Ireland.

Professor Harkness reported on this Scotch culm at the meeting of the British Association in Belfast in 1852, and Dr. Whitty supposes that it is more than probable that the anthracite in Cavan is a production of the bed in Scotland, which extends all the way between them, through the counties of Down, Armagh and Monaghan. He further stated that this culm, following the strike of the rocks to the N.E. and S.W., may be expected to be found in twenty-two other townlands which he named. He described the trial made for this culm, and illustrated the description with suitable diagrams; that it was found by analysis that this culm contains 77·64 per cent. of carbon, 4·35 of water and 18·01 of ash, and no bitumen; by another analysis of a specimen taken from a greater depth in the pit, it was found to contain only 4·28 of ash; it is ill-suited for ordinary domestic purposes, but is excellent for burning lime or bricks, or drying malt, when mixed with a small portion of bituminous coal or turf to ignite it. When made red it gives out a powerful heat, and continues it a great length of time. It is found also most efficient for smiths' work. As a mining speculation, the working of this bed ought to pay well in the county of Cavan, which is very much under cultivation, and in which lime has a wonderfully fertilizing effect on the soil, as it has in all slate countries, and where fuel is at present too scarce and too dear for any but a very limited burning of limestone, although that rock is abundant in several parts of the county. Coals from Troon, by a circuitous and expensive carriage, cost at Cavan 25*s*. a ton and upwards.

---

[*] See Philosophical Magazine for October 1854.

Dr. Whitty then went into much detail, describing the mode of working he would recommend in this bed, which stands nearly vertical, and entered into calculations to show that in the townland of Kill where the culm has been discovered, a statute mile in length, 50 feet average height over the lowest point, and 4 feet thick, would yield as much culm, selling it at 8*s*. per cubic yard, as would be worth £15,000; but from this sum of course the expenses of working should be deducted. He further showed, that as flexures exist in the grauwacke formation in Cavan, there is a great probability that the culm will be found in other localities in the county, in a direction transverse to the general strike, as well as in it; and concluded by stating that the discovery of this bed of coal, in a formation where it was supposed least likely to exist, strengthens his opinion, that coal and many valuable minerals exist in this kingdom in abundance, unknown to the proprietors of the soil, and he hopes they may yet be discovered, and rendered a fruitful source of commerce in the country.

Prof. WILLIAMSON exhibited a restoration of *Zamites gigas*, described more fully in Section D.

BOTANY AND ZOOLOGY.

BOTANY.

Remarks upon some Peculiarities discovered in Liquid Caoutchouc.

By T. C. ARCHER, *Liverpool.*

THE author stated, that he had discovered the cause of the black colour in india-rubber. The ordinary opinion, which had been copied from book to book, that the black colour was owing to the bottles, and other forms of the material, being dried by the natives in the chimneys of their dwellings, is incorrect, for caoutchouc has a peculiar property, by which light acts upon it very powerfully, and produces the black colour. In proof of this, Mr. Archer exhibited specimens of liquid india-rubber in white glass bottles. This liquid had been imported for the purpose of trying experiments as to its power of receiving brilliant colours, and it had evidently received an addition of some liquid ammonia, probably for the purpose of preserving its liquidity and preventing decomposition. In colour and consistency the liquid caoutchouc resembles milk; this fluid in white glass bottles had, by the action of light, become jet black next the glass, whilst the interior whiteness and liquidity are unimpaired; whereas, a similar sample of the material in a green glass bottle retains its original character. Mr. Archer thought this peculiar susceptibility to the action of light was well worthy of notice. He exhibited a specimen of caoutchouc from the west coast of Africa, the quality of which is evidently of a very superior character.

Mr. Archer also exhibited a series of diagrams of plants, which he had prepared at the instance of the Board of Trade, for educational purposes.

On some Materials for making Paper. By T. C. Archer, *Liverpool.*

The author remarks that Dr. Royle had brought under notice the fibrous materials of India, and he seemed sanguine they would prove useful in making so necessary a material as paper. From his own examination, however, he thought those materials were too harsh, and required too much labour to reduce them to a pulp sufficiently fine for making the ordinary letter-paper. Most vegetable fibres could be made into paper, and therefore there was no fear as to the supply of materials for the coarser kinds. The present difficulty was to supply paper for printing and writing upon. This paper required to be extremely white, and smooth in texture. All materials from the East Indies, except cotton wool, were destitute of that roughness of surface in the cells required to form a tenacious pulp, and when broken up they resembled straw, rather than the fine woolly fibre of linen rags broken to pieces. There was China grass, plantain fibre, jute fibre, the fibre of the paper mulberry, and the aloe fibre. These and other fibres he had examined, and they appeared perfectly smooth, hair-like tubes. Cotton, and old linen after use, and only after use, had both rough surfaces on their individual cells. He thought it an important point that cellular tissue used for paper materials should have an adherent surface, rather than a strong fibre, which had the means of attaching itself to its neighbouring fibres, and allowed the pulp to be thoroughly amalgamated. Instead of going to the East Indies, he suggested they should go to South America. He believed that the materials of a proper kind for paper could be procured there abundantly. He had been led to this conclusion by receiving a single sample of bark which he was told could be bought in unlimited quantities. In those countries, the more they cut some trees, the more luxuriantly they grew up. He was totally unable to tell them the name of the tree, as that was the only specimen he had seen. They would see by the specimen itself that this was a suitable material, possessing all the wooliness of cotton fibre, as he had proved by submitting it to a microscopic examination. Each individual cell was rough on the surface, and this he thought was the desideratum required. The plant had eight or ten layers of this fibre. He thought it belonged to the class Thymelaceæ, and was nearly allied to the Lace-bark tree. He thought from the palms of South America, from the grasses of the savannahs, and other natural products of that continent, more suitable materials could be found than could be derived from India. The bark of our own osiers when stripped off by the basket-makers would also yield a useful material. The material came from the Brazils.

On the Occurrence in Coal of peculiar Vegetable Organisms resembling the Sporangia of Lycopodium. By Professor Balfour, *M.D., F.R.S.E.*

The author stated that much discussion had recently taken place on the subject of coal, and that disputes had occurred which, in many instances, depended chiefly on parties choosing to define coal according to their own views of its microscopic structure. Coal is a *rock* variously constituted in different localities and even in different parts of the same coal-bed. It varies as regards the quantities of ash and carbonaceous matter as well as in regard to structure. Dr. Balfour stated that he did not believe coal to be in all cases formed of coniferous wood. No doubt in some instances true punctated woody tissue, *i. e.* a circle and dot, could be seen, as in Bohemian needle coal. But even the presence of punctated tissue must not always be considered as positively deciding the plant to be coniferous, for the same structure is seen in such plants as *Drimys Winteri*, and in *Illicium floridanum*. Many tissues supposed to be coniferous were, in reality, pitted vessels, and modifications of scalariform tissue, such as are seen in Lycopodiaceæ and Ferns, and which appear to characterize Sigillarias and Lepidodendrons. Dr. Balfour stated that the circular bodies supposed to be the ends of woody vessels, as seen on transverse sections of coal, were mere cells. Dr. Balfour alluded particularly to the occurrence of spore-like bodies in most coals and to the presence in many coals of large rounded bodies, having the appearance of sporangia and resembling those of Lycopodium. These circular sporangia presented a cavity containing carbonaceous matter. Dr. Balfour also alluded to the occurrence of a peculiar inflammable matter in the coals containing these sporangia; and he suggested that this resinous matter might be allied to the Lycopode powder of the present day.

On Associations of Colour and Relations of Colour and Form in Plants.
By Professor GEORGE DICKIE, *M.D., Belfast.*

The Professor remarked, that relations in the form, structure, number and position of organs are familiar to every botanist: *à priori* it might have been inferred, that order prevails also in the distribution of colours. This is not only the fact; there are, besides, obvious indications of a relation between the colour and form of certain organs. His attention was first directed to the subject in April 1853, and the facts here recorded were demonstrated to scientific friends at that date. A brief account of the subject was communicated to the Belfast Natural History Society in October following. Certain associations of colour have, however, been known to artists who have cultivated the special department of flower painting: any relation between form and colour seems to have escaped notice, and even erroneous views have been promulgated; for instance, by Ruskin in his 'Lamps of Architecture.' The subject appears to have been very much, perhaps altogether overlooked by the botanist. The presence of all the colours, red, yellow, blue, which form compound or white light, is a physical want of the organ of vision. Among the lower tribes of plants, the Algæ may be mentioned as remarkable examples of constantly associated colours. Such, in fact, is the foundation of Prof. Harvey's classification, who divides them into red, green and olive. Among the red there are many which have a red-purple hue, and among the olive not a few are yellow-green. Red and green are complementary, and red-purple and yellow-green stand in the same relation. Among mosses we find the red or red-purple peristome associated with the green or yellow-green capsule, and the same is true of their stems and leaves. In flowering plants the associations of certain colours are so numerous, that it is unnecessary in this summary to do more than mention a few examples. In the leaves of *Caladium pictum*, *Coleus Blumei*, and *Victoria Regia* we find red or red-purple associated with green or yellow-green. The same is true of the pitcher-like organs of Sarraceniæ, Nepenthes, and Dischidia. In the flower similar associations of various kinds are common. We need not expect to find in a corolla or any other organ the primaries red and yellow, or blue and red, associated and in contact. The red has green, the yellow has purple, and the blue has orange associated. Of the primaries, blue is rarest,—many cases so denominated being, in fact, blue-purples. In the flower yellow predominates, hence the very general diffusion of purple of various degrees of intensity. Purple being of such general occurrence in the flower, we can now understand why yellow is the most common colour of pollen: some exceptional cases seem to confirm this; in the turn-cap lily, for example, the red pollen is associated with the green filaments. The colour of the flower may have its complement in that of other parts, as stem, leaf, &c. Sometimes the associated colours are not visible at the same time. The inside of a ripe fig is red-purple, the outside yellow-green. Sometimes a yellow corolla is succeeded by a purple fruit. Direct exposure to light, although usually and in general correctly admitted to have a direct relation to intensity of colour in organisms, appears not to be necessary in every instance. The plant, however, must receive the light at some part or other, in order to produce that intensity of colour observed in the coats of seeds, in the interior of fruits, and in the tissues of subterranean organs. In conclusion—1. The primaries, red, yellow and blue, are generally to be seen in some part of the plant. 2. When a primary occurs in any part of the plant, its complement will usually be found in some other part, or at some period or other of the development of the plant. I have found, in not a few instances, in the animal kingdom similar associations of colour; birds, mollusca and radiata present many obvious examples. We may next examine the relation between colour and form; and the remarks are, for the present, confined to the flower. Law 1. In regular polypetalous and gamopetalous corollæ the colour is uniformly distributed; that is to say, the pieces of the corolla, being all uniform in size and shape, have each an equal proportion of colour. Examples of this occur in Primulaceæ, Boragineæ, Ericaceæ, Gentianeæ, Papaveraceæ, Cruciferæ, Rosaceæ, Cactaceæ, &c. Law 2. Irregularity of corolla is associated with irregular distribution of colour. The odd lobe of the corolla in such is most varied in form, size and colour. When there is only colour, it is usually more intense in the odd lobe; when there are two, one of them is very generally confined to the odd lobe, Sometimes, when only one colour is present, and of uniform intensity in all the pieces, the odd lobe has spots, or streaks of white. The odd lobe, therefore, in irregular flowers, is distinguished from the others not merely by size, form and position, but also by its colour. Papilionaceæ, Labiatæ, Scrophularineæ, &c. are examples. In some cases, as Gloxinia, Achimenes, Rhododendron, &c., in which irregularity of flower is less marked, the two pieces on each side of the odd lobe frequently partake of its character as regards colour. In some thalamiflorous Exgens (as Pelargonium, Tropæolum, Æsculus), &c., with irregularity of flower, owing chiefly to difference in the size of the pieces, the largest are most highly coloured. Law 3. Different forms of corolla in the same inflorescence often present differences of colour, but all of the same form have the same colour. The Compositæ are examples; when there are two colours, the flowers of the centre have one colour and uniform in its intensity; those of the circumference also agree in this respect, but have the other colour. The first two laws prevail in monocotyledons as well as in dicotyledons. In the former the calyx and corolla generally resemble each other in structure, shape, and in colour also. The law of the contrasts is therefore simpler in monocotyledons than in dicotyledons. The former may be symbolized by the triangle, three and six being the typical numbers in the flower; the latter by the square or pentagon, four and eight, five or ten, being the prevalent numbers. Simplicity of figure corresponds with simpler contrast of colour in the one, while greater complexity of colour and of structure are in direct relation in the other.

According to the investigations of Brongniart, there has been progressive increase of angiospermous dicotyledons up to man's epoch. Among them we find the floral organs with greater prominence in size, form and colour, and such prominence of the "nuptial dress" of the plant is peculiarly a feature of species belonging to natural families which have attained their maximum in man's epoch, and are characteristic of it.

Prof. Henslow drew attention to the adornment of an African dress, exhibited by Mr. James Yates. It consisted of the fruit of a species of grass closely resembling that which produced the product known under the name of Job's Tears.

On the Stipular Glands of Rubiaceæ. By G. Lawson.

The presence of peculiar secretory glands on the interpetiolar stipules of Rubiaceæ was first pointed out by Dr. Weddell, of Paris, a few years ago. Dr. Weddell and other observers have regarded this as a feature of structure strictly limited to that section of the order termed Cinchoneæ, which consists chiefly of arborescent species, and includes the plants yielding cinchona barks; but Mr. Lawson's observations lead to the conclusion, that the so-called cinchonaceous glands are equally prevalent in Galieæ, and must therefore be regarded as of universal occurrence throughout the order. Several of the most recent writers on systematic botany have elevated the two sections of Rubiaceæ to the rank of separate orders:—a view which, while supported in a remarkably satisfactory manner by the habits of the plants and their geographical distribution, is not sustained by any important structural characters. The discovery of cinchonaceous glands in Galieæ, establishes an unsuspected point of relationship between those two ideally distinct groups of plants, and seems to indicate the propriety of retaining them as well-marked sections of one natural order. The principal structural distinction between the two orders depends upon the theoretical notion adopted of the nature of their foliaceous organs, which has led to the discussion of the subject at different times by DeCandolle, Lindley, Bentham, and other distinguished botanists. Instead of endeavouring to reduce a portion of the leaves of Galieæ to stipules, as had been generally done, Mr. Lawson is of opinion that the simplest way of viewing the Rubiaceæ is to regard them all as verticillate-leaved plants, the so-called stipules of Cinchoneæ being so evidently reduced leaves.

Some Observations on the Morphology of Pines and Firs.
By the Rev. Professor J. M'Cosh, *LL.D., Belfast.*

In the cones of pines and firs there is obviously one set of spirals proceeding from right to left, and another set proceeding from left to right; these by their intersection give a series of rhomboidal figures on the surface of the cone; and on measuring the angles of these figures they were found to be (approximately) 120° above and below, and 60° at the sides. The scars of the fallen leaves also form two sets of spirals on the branch, and these by their intersection also produce regular rhomboids. Each of the sets of spirals on the cone and branch is composed of several spirals, which may be called threads. The number of threads on any given set of spirals is always one or other of the following (the usual numbers in Phyllotaxis), 1, 2, 3, 5, 8, 13, 21, 34, &c., in which scale every succeeding number is made up by the addition of the two preceding; this holds true of all the Coniferæ. The numbers of threads of the two opposite sets of spirals are always contiguous ones in the above scale; thus if the number of the one be 5, that of the other must be 3 or 8. The number of threads in the spirals seems definite for every species. There seems also to be a regularity in the number of turns round the axis taken by the spirals in ascending from the base to the apex of the cone. He (Dr. M'Cosh) had observed that the expanded cones are often types of the particular species of tree on which they grow, and he illustrated this by examples.

Some further Observations on the Correspondence between the Leaf-Venation and Ramification of the Plant. By the Rev. Professor J. M'Cosh, *LL.D., Belfast.*

The author set out with referring to previous observations of his, of which an abstract will be found in the Sectional Reports for 1852. The correspondence may be illustrated under two general heads:—1st. Between the disposition of the branches on their axis, and that of the veins on the midrib, or other veins from which they spring. In trees where the leaf has no leaf-stalk, the tree is feathered from the ground; and, on the other hand, when the leaf has a leaf-stalk, the tree has a bare unbranched trunk. It had been objected that the beech leaf has no leaf-stalk; whereas the tree has often an unbranched axis. This objection he had been able to answer to the satisfaction of the gentleman who urged it. It is customary in planting out beeches to strip off the lower branches, and cut over the axis, and hence the form which the plant often assumes in lawns; but the beech, when uneaten by cattle and not drawn up by being planted in the heart of a wood, is feathered or branched from the base. This may be seen from its mode of growth in hedges. He would have it to be understood, however, that this correspondence does not imply that the tree and leaf necessarily assume precisely the same shape. Thus, when the leaf is pinnate, there is no correspondence between the form of the leafage and the form of the tree. He was inclined to think that when the leaf is pinnate, as in the ash and mountain ash, the tree is decomposite; that is, instead of sending forth one main axis from top to bottom, it sends off in a scattered way branch after branch, till the axis is lost. 2nd. The branch goes off from its axis at much the same angle as the vein goes off from the midrib or lateral vein. There was little difficulty in establishing this in plants with woody structure, or in herbaceous plants which have a true branch, and not a mere flower-stalk. The only exceptions which he had found in plants with true branches were those with decurrent leaves, such as thistles, where the natural angle seems to be affected by the decurrency of the leaf. But there was a difficulty in establishing the correspondence in herbaceous plants, which either have no branch, or in which it is difficult to say whether we have a branch or merely a peduncle or leaf-stalk; the more so as botanists had not laid down any rule by which to distinguish between branch and peduncle. He had found it necessary in applying these views to herbaceous plants, to distinguish between what he might be allowed to call the primary and secondary angle, both of venation and ramification; meaning by the primary angle, that made by the main branches and the main lateral veins; and by the secondary, that made by the lesser branches or lesser veins proceeding from the others. He had found in many cases, that the angle at which the peduncle or flower-stalk goes off corresponds, not to the primary, but secondary angle of this leaf. [Appended to the paper was a list of 200 species of plants measured by him since 1852.]

On some Traces of Harmonious Colours in Plants and the Plumage of Birds. By the Rev. Professor J. M'Cosh, *LL.D., Belfast.*

The Professor set out with remarking, that he had been convinced for several years past that the colours of plants would be found in beautiful accordance with the law of harmonious colours, and that he had enunciated the doctrine in a paper read before the Natural History Society of Belfast in May 1853. In his reading since that date he had discovered that there were beautiful glimpses of this truth in the writings of several colourists such as Field, though as far as he knew, the subject had not been pursued botanically, or introduced into botanical works in this country. He further acknowledged that since that time he had received assistance from his colleague Dr. Dickie, who has been prosecuting the subject in a more scientific manner. He then proceeded to give the results of his own observations. Taking up the three secondary colours, green, purple, and orange, he showed that when these colours are found in nature, they have often the corresponding harmonious colours in juxtaposition:—

1. *Green harmonizing with Red and Russet.* This is the most common harmony in the vegetable kingdom. Harmonizing with the green leaves of plants we have often red flowers and red fruit. The eye delights to see the red berries peeping forth from the green foliage of the mountain-ash or holly. Not unfrequently, also, the green leaves harmonize with the red or russet of the young stems and leaf-stalks.

2. *Purple harmonizing with Yellow or Citrine.* This is the second most common harmony. So far as he had been able to observe, purple of various shades and hues —such as red-purple where there is a preponderance of red, and blue-purple where there is a preponderance of blue— is the most common colour of the petals of plants. Contrasting with it, we have often a yellow heart in the plant; very often the anthers and pollen are yellow. It is interesting to notice, that according to the hue of the purple so is the hue of the contrasted yellow. Thus, in the potato and bitter-sweet, the flower is blue-purple and the stamens are red-yellow, while in the garden polyanthus the outer rim of the corolla is red-purple and the heart is greenish-yellow. The harmony between purple and citrine may be seen in decaying vegetation.

3. *Orange harmonizing with Blue and Olive.* This harmony is less frequent, still it is found in nature. Plants with a blue flower have often orange anthers, and some syngenesious plants have an orange flower and an olive involucre. He had found it extremely interesting to trace this harmony through the vegetable kingdom. Sometimes the harmonious colours are on the same organ. Thus blue and orange are found on the petals of the Forget-me-not, yellow and purple on the Pansy, Calceolaria, Mimulus, Antirrhinum, &c. More frequently the harmonious colours are found on different organs. Thus we have frequently purple petals with yellow anthers. Often the corolla is of one colour, and the calyx the complementary colour. He went on to say that the final cause of all this was very evident; the arrangements are in accordance with the structure and likings of the eye. But there must also be an efficient cause. Possibly this was to be found in the chemical changes of plants, and the relation of chemical agents to colours. But it is surely also possible that there may be a reality in colour as there is in heat. This juxtaposition of contrasted colours in plants does look as if there were polar forces operating in the distribution of colours. On the supposition that colour is in the object, we can account for colour as seen by the eye by supposing that every colour on the surface of an object repels the like colour, and allows the others to be absorbed. This was, however, but a vague hypothesis, in the absence of a better, and was not to be confounded with the co-ordinated facts which he had presented in regard to harmonious colours in plants. Dr. M'Cosh went on to say that he had also noticed traces of harmonious colours in the plumage of birds.—1. Black and white found in birds of tamer and plainer plumage. 2. The second most common harmony is a red-yellow associated with a dark blue. This reddish yellow takes various hues; sometimes it is a tawny colour, at other times orange, and in some birds it is a bright scarlet. The blue is also of various shades and hues, sometimes being a kind of dark grey, at other times a very blue purple, and not unfrequently of a greenish tinge. 3. In the more ornamented birds the harmonious colours are green and red. Sometimes we have a bluish green with a scarlet, at other times a yellowish green with a blue-purple.

On some New Mosses, and on recent Additions to the Muscology of Liverpool. *By* F. P. Marratt.

On the Arrangement of the Air Canals in the Nymphæaceæ (the Water Lilies). *By* Maxwell T. Masters, *Lecturer on Botany in St. George's Hospital.*

As the result of his examination of the air canals in the leaf-stalks and flower-stalks of various species of Nymphæaceæ, Mr. Masters divided them into three principal groups, as follows:—1. Where the arrangement of the air canals is similar in petiole and peduncle, there being four central canals, surrounded by smaller tubes. Under this group he included *Nymphæa odorata, minor, alba, nitida,* and *pygmæa,*—all which belong to the section Castalia. 2. Where with an arrangement of the petiolar air tubes similar to that just mentioned in the first group, there is a concentric arrangement of the *peduncular* air tubes, there being a number of large canals placed around the central axis of the flower-stalk, and encircled by one or more rows of smaller tubes, each row containing, however, twice as many tubes as that immediately interior to it. Of the species enumerated the following belonged to this group:—*Nymphæa cærulea* and *cyanea*, belonging to the section Cyanea; *Nymphæa Mexicana* and *micrantha*, belonging to the section Castalia. 3. The third group includes those species in the petioles of which there are two large semi-ovate canals, and in which the arrangement of the peduncular air tubes is of the same concentric character as had been described in the second group. The species in which this disposition occurs are all comprised in the section Lotus. They are—*Nymphæa rubra, Lotus dentata, dentata major,* and *Devoniana.* The author thinks that although there are many species of *Nymphæa* not alluded to in his remarks, yet it may be fairly assumed that the disposition of their air canals is subject to one or other of the foregoing modifications; and with reference to the difference of opinion as to whether many of the so called species of *Nymphæa* are to be regarded as such, or merely as varieties, he observes that if the arrangement of the air canals is of little value as evidence of the latter view, at least it cannot be adduced in support of the former.

Drawings of various marine animals were exhibited by the Rev. — Price. One of the drawings illustrated the young state of the common starfish (*Uraster rubens*).

On the Nature of the Torbanehill and other Varieties of Coal. *By* Professor Redfern, *M.D., Aberdeen.*

Mr. Redfern introduced the subject by remarking, that the great interest which it has recently excited owes its origin to the practical question raised in the jury trial, Gillespie *v.* Russel, rather than to investigations into the characters of coal pursued for their own sake. He stated his conviction that the term "coal," as at present applied in ordinary life, is sufficiently understood for all commercial purposes, for the construction of leases, &c., and that differenses of opinion as to the scientific definition of coal ought not to interfere with the popular acceptation of that term. The author then pointed out that the geological position of the Torbanehill coal is like that of all others; and he produced Dr. Fyfe's tables of the chemical composition of coals to prove that the Torbanehill coal contains all the chemical ingredients of coals, in nearly the same proportions as in some of them, and that it contains nothing which is not found in coals. He produced specimens to show that the Torbanehill coal is laminated, and that it is full of fossil plants visible to the naked eye. On fractured surfaces he showed numerous angular facets variously inclined, and stated that these as well as large portions of the surfaces of the larger fossils may often be seen to be produced by vessels of plants by the use of a pocket lens. As these fossils have a similar microscopical structure to the whole mass of the coal, and this contains 65½ per cent. of carbon, he urged that these facts are in themselves almost conclusive evidence that the seam is a mass of vegetable matter. Small cubical blocks of Torbanehill and other coals show above and below small rounded yellow spots set in a dark mass, but on their four sides these spots are elongated in the direction of the laminæ. There are no such appearances as those presented by a block of wood in any coal whatever; whilst those presented by the Torbanehill coal are exactly the same in kind as those of other coals, though differing in degree. Microscopical sections taken horizontally and vertically always differ in the same manner as the surfaces of cubical blocks. All vertical sections are alike in the Torbanehill and other coals; all horizontal sections are alike, but widely different in all these coals from vertical sections. The striated appearance of vertical sections is therefore not due to coal being fibrous like wood, but to its laminæ, which a vertical section cuts across as one would cut through the leaves of a book. The author denied *in toto* the correctness of two important statements made in a paper recently published by the Microscopical Society of London, and affirmed in opposition to these, that horizontal and vertical sections of the Torbanehill coal are never alike, but differ like those of other coals; also, that coal and wood differ as widely as a laminar and a fibrous structure. He proceeded to give a lengthened and systematic description of the various microscopical appearances of coal, illustrating these by coloured drawings and sun-pictures. He pointed out that the Torbanehill and other coals are in great part made up of rounded flattened yellow masses separated by dark matter made up chiefly of vegetable tissues in a fragmentary state. There are also several other bodies, such as spores, &c., shown on microscopical examination; but it is important to bear in mind, that whatever be the interpretation of the microscopical appearances in the Torbanehill coal, there is not a single character presented by it which is not found in other coals. The author concludes from his investigations, that coal, Cannel coal especially, is the result of maceration, disintegration, and chemical changes taking place in a mass of vegetable matter, the nearest approach to which at present is that presented by a very fluid peat-bog. He believes that in geological position, chemical and histological characters, the Torbanehill coal is like other Cannel coals; and that it differs from them in being more valuable for the production of gas, and consequently less valuable for the formation of coke.

Account of some Experiments made on the Influence of Coloured Glass on the Growth of Plants in Sea-Water. By ROBERT WARINGTON, *F.C.S.*

Mr. Warington found that the red sea-plants grew best in cases, the light supplied to which was allowed to pass through green coloured glass, and that the brown and green confervoid growths were thus destroyed.

On the Restoration of Zamites gigas *from the Lower Sandstone and Shale of the Yorkshire Coast. By* Professor W. C. WILLIAMSON, *F.R.S., Manchester.*

The author commenced by referring to the notices by Young and Bird, Prof. Phillips, 'The Fossil Flora,' and the labours of Mr. James Yates in connexion with *Zamites gigas*. He then explained his views of the structure and habit of the plant, regarding it as resembling the elongated cylindrical stems of *Cycas circinalis*, rather than the more spheroidal ones of *Encephalartos horridus*. He then described the subterranean buds, the bark, the fronds or leaves, and their connexion with the stem,—of all which parts he exhibited specimens, and in which the general resemblance to living Cycads was very obvious. He then dwelt at some length on the remains of the inflorescence found at Runswick, on the Yorkshire coast, of which he had met with two distinct forms: the one a curious scaly axis, prolonged in a peculiar pyriform manner, which latter part has been invested by a cortical substance, consisting of oblong cells, arranged perpendicularly to the axis. This portion Prof. Williamson regards as having probably been the antheriferous portion of the plant. A second type consists of a concave disc, which has evidently terminated the woody axis, and been margined by a peripheral circle of radiating bracts. On the upper surface of each of these bracts are two small oblong depressions, which Prof. Williamson supposed may have supported two ovules; but, at the same time, pointed out the great uncertainty respecting the exact physiology of these portions; though the numerical correspondence between these ovules, as usually seen in the cycadean cones and the depressions on the surface of the bracts, seems to indicate the probability of such an allocation of parts. The result of the investigation shows that, though the general habit of the plant is that of a true Cycad, its inflorescence has very widely diverged from any known type of that variable class, and, consequently, the utmost caution is necessary in determining the general nature of the plant from such limited portions of the organism. The elementary materials are often the same in the recent and fossil forms; but, being differently distributed, new and unexpected combinations are continually occurring, of which *Zamites gigas* is a curious and striking example.

On Stangeria Paradoxa. *By* JAMES YATES, *Esq., M.A., F.R.S.*

Stangeria Paradoxa is a plant belonging to the natural order of *Cycads*, and was observed a few years ago in the vicinity of Port Natal. At first only leaves were sent to Europe. They resembled those of certain kinds of ferns, and differed essentially from those of all known Cycads. Hence the new plant was regarded as a fern, and referred to the genus *Lomaria*. In the year 1851, however, a plant came from Natal to the Chelsea Botanic Garden with a stem as well as leaves, and soon after Professor Balfour of Edinburgh received a cone. They agreed exactly in their distinctive characters with the stems and cones of all the known genera of Cycads; and, being determined to belong to this natural order, the new genus *Stangeria* was so named after the enterprising and meritorious Dr. Stanger, then resident at Natal.

The stem most nearly resembles that of the West Indian genus *Zamia*. It is short and thick, covered with a brown cuticle, and marked by parallel bands and tubercles. These appear to have originated in the bases of leaves, the scars of which have been gradually effaced as the stem has enlarged. The section exhibits a single cylinder of woody fibre.

The leaf of *Stangeria* is distinguished from that of ferns by its vernation. For, although the vernation of the Adder's-tongue is plicate, that of all dorsiferous ferns is circinate. The young leaf of such a fern is coiled up, and, if pinnate, its leaflets are also coiled up. In *Stangeria* the leaf-stalk rises erect and much longer than the blade, which is folded upon it and gradually rises, turning on the top of the stalk as on a hinge, until it is bent so far back as to make with the stalk an obtuse angle, in which position it remains fixed. In all other known Cycads the stalk is continuous with the midrib of the leaf, so that the whole leaf, including the stalk, forms a uniform curve without any angle. As the blade in the leaf of *Stangeria* increases so as to render its structure apparent, it is found that every leaflet is folded double along its own midrib, the upper surfaces of the two halves being in contact; and that all the leaflets, so folded, are applied to one another with an imbricate vernation. In this respect therefore *Stangeria* resembles a rose, an ash, or a leguminous plant.

The venation of *Stangeria* certainly resembles that of *Lomaria*, so as to account for the original mistake respecting the identity of these genera. The midrib of the leaflet sends off nervures at the distance of about a millimetre from each other; these very shortly bifurcate, and some of them become dichotomous by a second bifurcation; all then terminate in serratures, which are seen along each margin, and which are directed, as in the genus *Zamia*, towards the apex of the leaflet. The whole margin of the leaflet is formed by a nervure, which coincides with all the indentations of the serratures and communicates with the midrib through the bifurcate nervures. The serratures are irregular in their size, so as to render the margin of the leaflet uneven. In this respect also an analogy is perceptible between *Stangeria* and *Zamia*. So far as respects Cycads, the venation is peculiar, and is only met with elsewhere in ferns.

In consequence of the size and position of the leaflets, the form of the whole leaf is somewhat triangular, differing in this respect from all other Cycads, and approaching some of the ferns. With the exception of one or two pairs, which are turned a little towards the base, the lowest leaflets are the largest and longest, and are placed on short petioles and at right angles to the midrib. The upper leaflets diminish in length as they approach the apex of the leaf, and are directed more and more towards the apex. The petioles of the leaflets become shorter and shorter from the base of the leaf upwards, until they are effaced, and the leaflets become sessile so far as respects the lower margin, and this lower margin is decurrent. The midrib of the whole leaf terminates in a single leaflet, which consequently forms the apex of the leaf. The leaflets in the oldest plant which I have seen are twenty-seven in number; in the young plant or seedling they are four. Instead of the bright glossy green of other Cycads, the leaf of *Stangeria* is pale green and does not shine. The form of the leaflets is oblong-lanceolate and acuminate.

The following account of the male cone is taken from a plant now (September 1854) in flower at Kew: it bears two cones, each growing upright on a short thick peduncle. Scales not peltate; the external surfaces pale-green, downy, lozenge-shaped. The cone is pointed at the apex, between 4 and 5 centimetres long, and except in being very much smaller, bears a close analogy to the cone of the genus *Dioon*.

The nut, or seed, is nearly orbicular, and 1·5 centimetre in diameter.

To illustrate this communication, Mr. J. Yates exhibited a drawing of *Stangeria paradoxa*, and recent specimens of different parts of the plant; a male cone of *Dioon edule*; and a living specimen of a *Lomaria*. For previous descriptions he referred to Hooker, *Journal of Botany*, Aug. 1853, and Seemann, *Bonplandia*, Feb. 1854, p. 44.

ZOOLOGY.

On the Occurrence in the Infusoria of peculiar Organs resembling Thread-Cells. By Professor ALLMAN, *F.R.S.*

In an important monograph by Cohn on the *Paramæcium Bursaria*, this author maintains that the cilia with which the whole surface of the animalcule is covered are in reality much longer than their appearance in the living animal would lead one to believe. He founds this opinion on the fact, that when the animal is allowed to dry on the glass object-holder, it is seen to bristle with long rigid filaments, which he believes to be the cilia then for the first time become visible in their entire length, and in accordance with this view, he figures the animal covered with cilia very much longer than what the mere inspection of the living *Paramæcium* would justify.

Stein in his remarkable work on the Development of the Infusoria, refers to this opinion of Cohn, whom, however, he believes to be in error in supposing the long bristle-like processes of the dead animalcule to represent the *natural* length of the cilia in the living. He maintains, on the contrary, that these processes are the cilia *abnormally* lengthened under external influences, and he states that he has witnessed the same phænomenon in many other infusoria, in which he has always been able to induce it by the application of strong acetic acid, when the cilia suddenly extend themselves to three or four times their original length.

While recently engaged in examining the structure of a nearly allied animalcule, the *Bursaria leuca*, Ehr., a green variety of which was developed during the present autumn in great profusion in a small pond in the county of Essex, Dr. Allman witnessed an appearance exactly similar to that described by Cohn and Stein, but it soon became clear to him that the German naturalists had erred in their explanation of it, and he is now satisfied that the filaments in question have nothing whatever to do with the cilia, but are peculiar and very remarkable organs hitherto undescribed in the infusoria.

When this animalcule is examined under a sufficiently high power, minute fusiform bodies may be detected thickly imbedded in its walls. These bodies are perfectly colourless and transparent. They are about the $\frac{1}{2500}$th of an inch long. They may be easily witnessed at the margin, where they are seen to be arranged perpendicularly to the outline of the animalcule, but on the surface turned towards the observer their extreme transparency and want of colour renders it necessary to crush the animalcule beneath the covering glass, so as to press out the green globules which it contains, in order to bring the fusiform bodies into view. To these bodies the author proposes to give the name of *trichocysts*.

As long as the animalcule continues free from annoyance, the trichocysts undergo no change; but when subjected to external irritation, as occurs during the drying away of the surrounding water, or the application of acetic acid, or other chemical irritant, or the too forcible action of the compression, they become suddenly transformed into long filaments which are projected from all parts of the surface of the animalcule.

The rapidity with which this remarkable change is effected, joined with the great minuteness and transparency of the object, renders it extremely difficult to follow it, and for a long time the author could only satisfy himself of the fact that the fusiform bodies were suddenly replaced by the projected filaments. After continued observation, however, he at last succeeded in witnessing the principal steps in the evolution of the filament.

It is not difficult, by rapidly crushing the animalcule, to force out some of the trichocysts in an unchanged state. If the eye be now fixed on one of the isolated trichocysts, it will in all probability be seen, after the lapse of a few seconds, to become all at once changed, with a peculiar jerk, as if by the sudden release of some previous state of tension, into a little spherical body. In this condition it will probably remain for two or three seconds, and then a spiral filament will become rapidly evolved from the spherule, apparently by the rupture of a membrane which had previously confined it, the filament unrolling itself so quickly that the eye can scarcely follow it, until it ultimately lies straight and rigid on the field of the microscope, looking like a very fine and long acicular crystal.

This remarkable body when completely evolved consists of two portions, a rigid spiculum-like portion acutely pointed at one end, and continuous at the opposite end with the second portion, which is in the form of a fine flexible filament, less than half the length of the spiculum; this second portion is generally seen bent at an angle on the first. The form of these bodies is best observed in such as have floated away towards the margin of the drop of water and are there left dry by the evaporated fluid. Many of them, however, merely presented the appearance of a simple, long, fusiform spiculum, a condition probably depending on their less complete evolution.

The resemblance of the organs now described to the well-known *thread-cells* of the polypes and certain other lower members of the animal kingdom is obvious. That they are entirely homologous, however, with these bodies we can scarcely assert; their origin at least appears different; for if we admit the unicellular structure of the infusoria, we have the *trichocysts* apparently developed in the thickness of the cell-wall, instead of being produced in special cells, as we know to be the case with the thread-cells of the polypes.

On the Application of Cyanide of Potassium to killing Insects for the Cabinet.

By G. Bowdler Buckton.

The author observed that little or no information was to be obtained from writers on Entomology with reference to killing insects intended for future examination.

After noticing the remarkable manner in which some of the Orthoptera and Neuroptera are capable of resisting the action of sulphurous acid, and consequent unfitness of that substance for such a purpose, it was stated that the desired object may be conveniently effected in many cases, by subjecting the living insect to a moist atmosphere at a high temperature. A suitable apparatus was described, and likened to a diving-bell of thin and well-annealed glass, having an inner lining towards the top, of cork, upon which the specimen to be operated upon may be fixed by a pin. Suffocation quickly ensues on plunging the bell-mouth downwards into a basin of water at or near its boiling-point.

After noticing the certain and rapid manner in which the vapour of hydrocyanic acid acts on insect life, and objecting to its common use from its well-known poisonous and volatile properties, it was further stated that cyanide of potassium possesses similar useful properties without corresponding disadvantages. Chemists have been long aware of the peculiar change of this substance, by moisture, into hydrocyanic acid, ammonia and other products, and as the air always contains aqueous vapour, the salt slowly undergoes the same decomposition on exposure at ordinary temperatures. The requisite apparatus is very simple, and consists of a wide-mouthed jar of glass, fitted with a brass cap having an aperture capable of being closed pretty accurately with a slide. The cyanide of potassium, in coarse lumps, is placed under a false bottom of blotting-paper, which serves the double purpose of absorbing the moisture arising from the deliquescent nature of the salt, and is also permeable to the air. A small glass bell, for transferring an insect from the net to the aperture of the instrument, completes the apparatus, which may be carried into the fields. An insect usually dies in a space of time varying from forty seconds to two minutes; but in the larger Coleoptera and Lepidoptera a longer treatment is desirable, to provide against the possibility of resuscitation.

The author considered that the cyanide possessed many advantages over crushed laurel leaves, which cannot always be obtained. The salt, now so extensively used in the arts, is inexpensive and may be kept for any length of time in stoppered bottles, and is thus available abroad. The instrument, also, is always ready, for a charge of thirty or forty grains will keep up a poisonous atmosphere for a month or longer without renewal.

A singular instance of resistance to the action of the cyanide was then exemplified. An impregnated female of the Burnet sphinx (*Anthrocera Filipendula*) was placed in the instrument in company with the spectre moth (*Mormo Maura*). The large insect was dead in less than two minutes, but the Burnet was comparatively lively after the expiration of fourteen hours. It is worthy of note, that oviposition did not commence until liberation of the insect from confinement, possibly showing a knowledge on the part of the insect that such an atmosphere was fatal to the larvæ when excluded from the egg or injurious to the vitality of the egg itself. As both the larva and imago of *Tinea pellionella* were experimentally proved to be incapable of resisting the action of the vapour from the cyanide, a suggestion was made, that furs and stuffed specimens of natural history might be freed from moth by subjecting them to such an atmosphere. Of course this could not be used as a preservative, but solely as a cure for an existing evil. The action of the vapour upon the lungs is not of sufficient intensity to cause any annoyance to the operator.

On the Fauna of Liverpool. By ISAAC BYERLY.

The list of animals was very complete, and comprised some remarkable forms. Amongst these may be mentioned the following:—1. The bottlehead (*Hyperoodon Butzkopf*). In the stomach of two of the specimens captured great numbers of the horny beaks of cuttle-fishes were found, and these were impacted one in another, forming a continuous row. 2. *Trachinus vipera*. In this fish, Mr. Byerly had demonstrated the existence of a poisonous secretion at the base of its spines. 3. *Lissotriton palmipes*, the rarest species of British newt, had been taken near Liverpool. 4. Many of the rarer British fishes had occurred on the coast,—as the opah or kingfish, the Anglesey Morris, the *Torpedo nobilis*. 5. Many species of Nudibranchiate Mollusca had been taken; and one species, *Antiopa hyalina*, is not yet published, but will appear in the forthcoming part of Messrs. Alder and Hancock's work on these animals. 6. The occurrence of *Noctiluca miliaris* in large numbers was noted; and also that it then gave the water a rose-colour. The following is a list of the species of each great section of the animal kingdom:—Mammalia, 41; Birds, 196; Reptiles, 11; Fishes, 100; Mollusca, 185; Crustacea, 71; Lepidoptera, 695; Echinodermata, 10; Acalephæ, 14; Zoophytes, 68; Sponges, 5: about 1400 altogether.

List of Four Hundred and Forty Species of Shells from Mazatlan.
By P. P. CARPENTER, *B.A., Warrington.*

The author entered into a comparison between them and the shells of Panama (as catalogued by C. B. Adams) and other places. A very large proportion of the Mazatlan shells not having been yet described, all such results will be open to correction. A comparison of the shells collected by Mr. Nuttall on the Californian coast shows the remarkable fact, that scarcely any species are common to that coast and to Mazatlan, although these shells are generally called "Californian." The importance of tabulating accurate accounts of the faunas, not only of zoological provinces, but of special localities, was much dwelt upon; and it was suggested that very valuable aid to scientific inquiries could be given by the formation of separate collections belonging to different faunas. A beginning had been made in Liverpool by the present of a series of Mazatlan shells to the Free Museum (by Mr. G. Hulse),—which was exhibited to the Section. If merchants, captains, and sailors would exert themselves to obtain similar collections, not only the inhabitants of Liverpool, but the scientific world generally, would be much indebted to them.

On the Development of the Embryo of Purpura lapillus.

By Professor W. B. CARPENTER, *M.D., F.R.S.*

The flask-shaped capsule formed by these animals contains from 500 to 600 vitelline bodies, having the appearance of eggs; yet only from about 12 to 30 embryos are produced, each of these having from 20 to 30 times the bulk of the ovum from which it sprang; so that the material contained in the original mass of eggs must in some way or other have been appropriated by the comparatively few embryos which are thus developed at its expense. By MM. Koren and Danielssen, who had previously examined into this subject, it was affirmed that, after the segmentation of the vitelline bodies into from about 12 to 16 divisions, the whole of them coalesced into one conglomerate mass, which afterwards subdivided into pedunculate fragments, containing a larger or smaller number of the original yolk-segments, every one of these fragments becoming an embryo. Dr. Carpenter stated, however, that his own observations had led him to an entirely different view of the process; and that he felt the more confidence in the correctness of his interpretation of it, since it was obvious, from his predecessors' own statement, that they had not had the opportunity of witnessing the stages of the process which immediately preceded the conglomeration. He had himself examined so large a number of capsules, in which a considerable number of small free embryos presented themselves before the conglomeration of the great mass of the ova, that he could not doubt that they are generated independently of it. These embryos very soon come to possess a mouth between their two ciliated lobes; and this leads, by a wide œsophagus, ciliated in its interior, to a temporary gastric cavity. The embryos then attach themselves to the conglomerate yolk-mass; and by the action of these cilia, the small segments of which it is composed are driven down into their interior, which is soon distended by them. If a capsule be opened shortly after the conglomeration has taken place, embryos may be found attached to the yolk-mass, presenting various gradations of size; some being but little larger than the small free embryos seen in a previous stage, and having only a small quantity of yolk superadded to that which they previously contained; whilst others may have already acquired the bulk of the fully-formed embryo, though presenting no advance in development. Even in these last, however, the small yolk derived from their original ovum, may be shown (by crushing) to be imbedded in the accessory yolk thus derived from the conglomerate mass. Thus, then, the embryos developed from a small number of the egg-like bodies contained in the original capsule, actually eat up, though at a very early stage of their own evolution, the material supplied by the rest; and if they do not obtain this additional supply, or only ingest an insufficient amount of it, they become abortive, developing only the ciliated lobes, with more or less of the foot: one or more of these abortive embryos are often to be met with in the capsule near its maturity. The bodies which, after segmentation, coalesce into the conglomerate mass, Dr. Carpenter was inclined to consider as imperfectly fertilized ova.

On some Points connected with the Natural History of the Azores.

By Professor E. FORBES, *F.R.S.*

After giving an account of his views on the geological relation of the Azores to the continent of Europe, the author proceeded to make some remarks on a collection of Mollusca made by his friend Mr. M'Andrew. Amongst them were forty-four species of Gasteropoda, seven species of Lamellibranchiate Mollusca, and one species of Cephalopoda. Of these, the whole were referable to the Lusitanian Fauna, and only one species was found in America, and this was found also in the Canary Islands. There was a list also of eighteen species of land Mollusca; one or two of these were peculiar, but the rest belonged to the West Atlantic or Lusitanian Fauna.

On the Vascular System of the Lower Annulosa.

By T. H. HUXLEY, *F.R.S.*

Under the term Lower Annulosa the author included the Annelida, the Echinodermata, the Trematoda, the Turbellaria and the Rotifera,—in all of which there exists a peculiar system of vessels, which have hitherto been universally regarded as a blood-vascular system. Without considering the view he was about to lay before the Section to be fully demonstrated, the author said, that he had to offer very strong reasons for regarding the prevalent notion as incorrect. The vascular system of the higher Annulosa and of the Mollusca is in all cases a more or less specialized part of the common cavity of the body. The fluid which it contains is a corpusculated fluid; the propulsive organ, if any special heart exist, is a contractile sac, connected by valvular apertures with that common cavity. Now, although it might be incorrect to say that the vascular system of the lower Annelida is invariably distinguished by characters the opposite of these, still there can be no question that, as a general rule, such is the case; and this circumstance is alone sufficient to raise grave doubts as to the homology of the two systems. But these doubts are greatly strengthened when we take into consideration certain facts, which the author proceeded to lay before the Section. In the Rotifera there is a system of vessels, consisting of a contractile vesicle, opening externally, from which canals, containing long vibratile cilia, pass into the body. In certain Distomata, such as *Aspidogaster conchicola*, there is a system of vessels of essentially similar character; but the principal canals—those lateral trunks which come off directly from the contractile vesicle—present regular rhythmical contractions. The smaller branches are all richly ciliated. In other Distomata the lateral trunks appear to be converted into excretory organs, as they are full of minute granules; they remain eminently contractile; but their connexion with the system of smaller ramified vessels ceases to be easy of demonstration. As Van Beneden and others have shown, they still form one system; but the cilia are no longer to be found in the smaller ramified vessels, having sometimes vanished altogether; at others, being discoverable only here and there in the minute ultimate terminations of these vessels. In certain Nematoidea the vascular system is reduced to a couple of lateral contractile vessels, altogether devoid of cilia, but communicating, by a small aperture, with the exterior. Now, there is no doubt that, in all these cases, the "vascular system" is physiologically a respiratory and, perhaps, urinary system; while the common cavity of the body represents the blood-vascular system of the Mollusca and Articulata. However, Echinorhynchus possesses a vascular system of the same nature as that of a Nematoid or Distomatous worm, but presenting no cilia, and having no external opening; thus forming a closed vascular system, homologous with those previously described, and differing from them only in the fact of its closure. But from hence it is a very easy and natural transition to the vascular system of the Annelida; and the author stated his conviction, based not only upon these, but upon many additional reasons, that these so-called blood-vessels and those of the Echinodermata, form, in fact, only the final term of a series, of which the so-called water-vascular system of the Rotifera constitutes the commencement. If, however, these vessels have really nothing to do with the proper blood-vascular system of the higher Annulosa, with what system of organs are they homologous? In answer to this question, the author stated his belief, that they correspond with the tracheæ of Insecta, which present a similar, extensive, ramified distribution, and, in some cases, as in the larvæ of the Libellulidæ, constitute as completely closed a system of vessels.

On the Power by which Insects are enabled to adhere to Smooth Perpendicular Surfaces.

By THOMAS INMAN, *M.D., Liverpool.*

The author took a survey of the whole subject, and pointed out that there were three ways by which this object was effected:—1. by hooks, which were used when the surfaces were cylindrical, as in the grasses; 2. by suckers, which were perfectly free from hairs except a marginal fringe to keep the dust out; 3. by an adhesive secretion, which was spread over an immense number of microscopic hairs, each of which were attached to a large flap, and had a distended terminal development.

Hooks were to be found in every foot, but they were not uniformly accompanied either by suckers or adhesive bosses. The last were by far the most frequent, the former were very rare. In some very few instances, hooks, suckers, and adhesive flaps were present.

Dr. **INMAN** related the particulars of a case of partial Albinoism in a black man, illustrated with photographic representations of the individual thus affected. The white spots on the man's body were observed to become darker during the hotter parts of the year.

Dr. **LANKESTER** called attention to Mr. Woollaston's recently-published work on 'The Insects of the Madeira Islands,' a copy of which was exhibited to the Section. This work had been produced by the author with great labour and at a great expense, and was one of those works for which science is indebted to the patient and self-denying labours of their authors. He also called the attention of the Section to the magnificent colletion of insects, especially Coleoptera, made by the late Mr. Melly, of Riversley, near Liverpool, and which his son had thrown open to the inspection of the Members of the British Association.

On the Physiology of Cells in relation to Consciousness and Adaptive Movements. By THOMAS LAYCOCK, *M.D., York.*

Dr. Laycock communicated some of the views he entertained as to the relations of cells to consciousness, and to the adaptation to a definite object manifested in the movements and functions of organisms. These phænomena are variously interpreted in relation to consciousness. While, on the one hand, it was a firmly established opinion that vegetable organisms had no sensation, although they adapted themselves, often with exquisite skill, to external circumstances, of which Dr. Laycock adduced several examples,—on the other, it was an equally fixed doctrine that the lower animal organisms (*e. g.* insects) were as susceptible of pain as man himself. Now all these adaptive phænomena were manifested in the highest degree in that ultimate constituent of animated beings, namely, the microscopic cell; and yet whether the organism was unicellular, or composed of groups of individual cells, or evolved from a primordial cell, there did not appear the slightest ground for concluding that these were endowed with consciousness; it followed, therefore, that the whole of their adaptive phænomena were the result of a force inherent in them, but distinct from mind.

The entire structure of the higher organisms, whether vegetable or animal, being evolved out of cells, and the aim of their whole vital activity being directed to the attainment of the same object as that aimed at in cell action, viz. the well-being and happiness of the individual, it follows that in these that object may be aimed at wholly independently of the will or the consciousness. Such appears to be the case with vegetable organisms; but, to determine the presence or absence of these in plants, and even the lower animals, is necessarily beyond the reach of observation. It may be argued, indeed, from analogy, that they may possess a sense of pleasureable existence, inasmuch as such an endowment would be entirely compatible with that grand scheme of beneficent adaptation upon which all organisms and the entire creation are arranged.

As to insects, experiments show that it is at least very doubtful whether they feel pain; while the infinite variety of instruments supplied to them to administer to their own happiness, and the inherent skill which they display in the use of those instruments (illustrated by the mathematical accuracy with which the domestic bee constructs its hexagonal cell), might serve as some proof of the pleasure they may have in existence.

Dr. Laycock next proceeded to place the seat of these adaptive movements in the cells of the vesicular neurine which constitute the ganglia of the nervous system, and to show that these could re-act as a co-ordinating apparatus upon the instruments provided by Divine Providence for the well-being of the animal. He stated that the seat of consciousness is almost universally acknowledged to be in the ganglia within the cranium of Vertebrata; yet the headless trunk of a frog would leap away if it were irritated, or swim away if thrown into water. Hence the conclusion, that the cells of the vesicular neurine act under given circumstances as adaptively and yet as unconsciously as in the lowest forms of animal and vegetable life.

Dr. Laycock then extended these views to the cells constituting the vesicular neurine of the human brain; and argued that it might fairly be inferred, both *à priori* and from observation, that their endowments and modes of action were not inferior to those of the vesicular neurine in insects. It followed, therefore, that they also might act adaptively and in accordance with their assigned functions independently of the will or consciousness of the individual. To this automatic action (the link between man's spiritual nature and the external world) Dr. Laycock referred the phænomena of mesmerism, electro-biology, spirit-rapping, &c., and expressed his conviction that the derangement of the intellect which those phænomena implied could not be altogether harmless, but might lead, and, indeed, had led to permanent injury to the brain.

Mr. Moore exhibited several rare animals from the Museum of Natural History in Liverpool.

On the Anthropoid Apes. By Professor Owen, *M.D., F.R.S.*[*].

The Lecturer defined the known species of those large tail-less Apes, which form the highest group of their order (Quadrumana), and consequently make the nearest approach to man; he determined the true zoological characters of the known orangs and chimpanzees, as manifested by adult specimens; pointed out the relative proximity of the orangs and chimpanzees to the human species; and indicated the leading distinctions that separate the most anthropoid of those apes from man. The Professor then entered upon the subject of the varieties of the human species, and defined the degree in which the races differed from each other in colour, stature, and modifications of the skeleton. He entered upon a disquisition of the causes of these varieties, and proceeded to examine how far any of the known causes which modify specific characters could have operated so as to produce in the chimpanzees or orangs a nearer approach to the human character than they actually present. He pointed out some characters of the skeleton of the ape, *e. g.* the great superorbital ridge in the Gorilla Ape, which could not have been produced by the habitual action of muscles, or by any other known influence that, operating upon successive generations, produces change in the forms and proportions of bones. The equable length of the human teeth, the concomitant absence of any interval in the dental series, and of any sexual difference in the development of particular teeth, were affirmed to be primitive and unalterable specific peculiarities of man. "Teeth," the Professor proceeded to state, "at least such as consist of the ordinary dentine of mammals, are not organized so as to be influenced in their growth by the action of neighbouring muscles; pressure upon their bony sockets may affect the direction of their growth after they are protruded, but not the specific proportions and forms of the crowns of teeth of limited and determinate growth. The crown of the great canine tooth of the male *Troglodytes gorilla* began to be calcified when its diet was precisely the same as in the female, when both sexes derived their sustenance from the mother's milk. Its growth proceeded and was almost completed before the sexual development had advanced so as to establish those differences of habits, of force, of muscular exercise which afterwards characterize the two sexes. The whole crown of the great canine is, in fact, calcified before it cuts the gum or displaces its small deciduous predecessor; the weapon is prepared prior to the development of the forces by which it is to be wielded; it is therefore a structure foreordained, a predetermined character of the chimpanzee, by which it is made physically superior to man; and one can as little conceive its development to be a result of external stimulus, or as being influenced by the muscular actions, as the development of the stomach, the testes, or the ovaria." The difference in the time of disappearance of the suture separating the premaxillary from the maxillary bone, was not explicable on any of the known causes affecting such character.

---

[*] Delivered at the request of the Council at the General Anniversary Meeting of the Association.

There was not any other character than those founded upon the developments of bone for the attachment of muscles, which was known to be subject to change through the operation of external causes; nine-tenths therefore of the differences, especially those very striking ones manifested by the pelvis and pelvic extremities, which Prof. Owen had cited in his 'Memoirs on the Orangs and Chimpanzees,' published in the Zoological Transactions, as distinguishing the great chimpanzee from the human species, must stand in contravention of the hypothesis of transmutation and progressive development, until the supporters of that hypothesis are enabled to adduce the facts and cases which demonstrate the conditions of the modifications of such characters.

There was the same kind of difficulty in accounting for the distinctive characters of the different species of the orangs and the chimpanzees, as for those more marked distinctions, that remove both kinds of apes from man. And with regard to the number of the known species, Prof. Owen remarked, it is not without interest to observe, that as the generic forms of the Quadrumana approach the Bimanous order, they are represented by fewer species. The gibbons (*Hylobates*) scarcely number more than half-a-dozen species; the orangs (*Pithecus*) have but two species, or at most three; the chimpanzees (*Troglodytes*) are represented by two species.

The unity of the human species is demonstrated by the constancy of those osteological and dental characters to which the attention is more particularly directed in the investigation of the corresponding characters in the higher Quadrumana. Man is the sole species of his genus—the sole representative of his order: he has no nearer physical relations with the brute-kind than those which arise out of the characters that link together the great group of placental mammalia, called "Unguiculata."

In conclusion, the Professor briefly recounted the facts at present satisfactorily ascertained respecting the antiquity of the Quadrumana and of man upon the surface of the earth. At the time of the demise of Cuvier, in 1832, no evidence had been obtained of fossil Quadrumana, and the Baron supposed that both these and the Bimana were of very recent introduction. Soon after the loss of that great re-constructor of extinct species, evidence with regard to the fossil Quadrumana was obtained from different quarters. In the oldest (eocene) tertiary deposits in Suffolk, specimens of jaws and teeth were found, that unerringly indicated the former existence of a species of monkey of the genus *Macacus* (*Macacus eocenus*). About the same time, the tertiary deposits from the Himalayan mountaias gave further evidence of the Quadrumana; jaws, astragali, and some other parts of the skeleton, having been found completely petrified, and referable to the genus called *Semnopithecus*, which is now restricted to the Asiatic Continent. Dr. Lund discovered in Brazil fossil remains of an extinct platyrhine monkey, surpassing any known Cebus or Mycetes in size: the platyrhines are peculiar to South America. Lastly, in the middle tertiary series in the south of France, was discovered a fragment of the lower jaw, proving that at that period some species of the long-armed ape (*Hylobates*) must have existed. But no fossil human remains have been found in the regularly deposited layers of any of the divisions (not even the pliocene) of the tertiary series. Human bones have been found in doubtful positions, geologically considered, such as deserted mines and caves, in the detritus at the bottom of cliffs; but never in tranquil undisturbed deposits, participating in the mineral characters of the undoubted fossils of those deposits. The petrified Negro skeletons in the calcareous concretes of Guadaloupe are of comparatively recent origin. Thus, therefore, in reference both to the unity of the human species, and to the fact of man being the latest, as he is the highest, of all animal forms upon our planet, the interpretations of God's Works coincide with what has been revealed to us as to our own origin and zoological relations in his Word. Of the nature of the creative acts by which the successive races of animals were called into being we are ignorant. But this we know, that as the evidence of unity of plan testifies to the oneness of the Creator, so the modifications of the plan for the different modes of existence illustrate the beneficence of the designer. Those structures, moreover, which are at present incomprehensible, as adaptations to a special end, are made comprehensible on a higher principle, and a final purpose is gained in relation to human intelligence; for, in the instances where the analogy of humanly invented machines fails to explain the structure of a divinely created organ, such organ does not exist in vain, if its truer comprehension in relation to the Divine idea lead rational beings to a better conception of their own origin and Creator. The discourse was illustrated by drawings and diagrams of the principal external and osteological characters of the different species of orangs and chimpanzees, and of the different varieties of the human race.

On the Anatomy of the Great Ant-eater. *By* Professor OWEN, *M.D., F.R.S.*

Exhibition of Living Sea Animals. *By* ROBERT PATTERSON, *Belfast.*

The animals exhibited were chiefly species of Jelly-fishes, caught by Mr. Price, of Birkenhead. One of the species was the *Cydippe pileus.*

Mr. PATTERSON exhibited specimens of *Priapulus caudatus*, procured while digging for bait on the mud-bank at Holywood, County Down. As other specimens had been obtained under precisely similar circumstances, Mr. Patterson thought it probable that this species was less rare in certain localities than had been previously supposed.

On the Medicinal Leech. *By* J. RICHARDSON, *Hull.*

The author exhibited a large number of the cocoons or egg-cases of the medicinal leech, and gave a short account of the development of the young leech in the ovum.

On a supposed New Species of Felis. *By* Capt. WIDDRINGTON, *F.R.S.*

Remarks on the British Species of Foraminifera.
By Professor W. C. WILLIAMSON, *F.R.S., Manchester.*

The author first referred to the labours of his predecessors. Walker figured 22 species, of which 13 are good ones; Montague 35 species, 18 being true ones; Fleming added no new ones, but divided Montague's forms into 8 genera; Dr. Macgillivray published 12 supposed new forms, of which but 2 were new to Montague. The author has now obtained 30 genera, 59 species, and a vast number of varieties. In deciding on the claim of individual forms to specific rank, whenever varieties, however extreme, were found to be connected by intermediate links, such varieties were recognized as belonging to the same species. He then illustrated the extraordinary extent to which difference was compatible with specific identity, by specimens taken from the genera *Lagena, Entosolenia* and *Cristellaria*, and concluded that whilst the individuals of some species displayed the most marvellous tendency to variation, others are as constant to their typical characteristics. Three primary structures were shown to enter into the composition of the Foraminifera:—1st. The Hyaline, usually consisting of a transparent vitreous carbonate of lime, with usually numerous foramina; 2nd. The Porcellanous, white, opake, and rarely foraminated; 3rd. The Arenaceous, mainly consisting of agglomerated grains of sand. Irregularities in their development were described; and a few indicative evidences of the existence of fissiparous generation amongst the soft uncalcified animals pointed out, with observations on their distribution on the British coasts. But, since the paper was an epitome of some facts which will be more fully elucidated in the joint work of the author and Dr. Carpenter, about to appear amongst the publications of the Ray Society, this outline will suffice for the present.

MISCELLANOUS.

On Literary and Philosophical Pursuits as conducive to Longevity.
By Dr. FOWLER, *M.D., F.R.S.*

While young and amusing myself with translating and re-translating some passages in Cicero, my attention was much arrested by the following, in his essay *De Senectute*, "Manent ingenia senibus, modo permaneant studia et industria." My past experience has satisfied me as to the certainty of the fact. But it has not been till lately that I have been able to find a physiological explanation of it.

All the functions of the mind are affected by corresponding functions of the body, and it is by the circulation in the minute arteries of our organs of brain, senses, &c., that they are kept in a sensitive and active state. After the nerves of a frog's leg had been divided some weeks, its muscles contracted feebly when zinc and silver were in contact with the crural nerve and each other; but when I brushed the skin so as to produce a slight redness, both sensibility and contractility were restored. Now, the effect of thinking has an effect on the blood-vessels analogous to brushing, in so far as it accelerates the circulation of the blood through them. Any one who has attended blood-letting must have observed that the stream is accelerated by any exciting thoughts, and blushing is attributable to a like acceleration. So, too, is the inflamed appearance of the features expressive of anger. But our conceptions, also, are vivid in proportion to the accelerated flow of blood through the brain, medulla oblongata, and organs of sense. Now, there is not only an accelerated flow of blood in the brain while we are thinking, inducing more vivid conceptions, but there is a retransmission from such conceptions to the functional parts appropriated to act in accordance with such conception. The sufficient ratio for this process seems to be to keep all sound parts of our organs in a state of functional efficiency, and to repair such as are unsound. Of this the restoration of Cretins to sense and health, by rational treatment of body and mind, supplies a satisfactory example.

To ensure such uninterrupted recurrence of hopeful conceptions as may retransmit a continued supply of pure blood to all the structures of the body employed in thinking, pure air, water, and exercise are essential. I cannot but attribute the continuance of my own faculties mainly to frequent washing the whole surface of my head, neck, and face with cold water, yellow soap, and a large nail brush. By this all the sentient extremities of the fifth pair of nerves are kept free from pressure by the imbibition of water, revivified by the arteries accompanying them, and thus a direct and free communication is kept up between the brain and all the organs of sense, so that our observations may be made with accuracy, and result in clear and abiding conceptions. These will constitute the materials of some worthy purpose, and furnish occupations to the mind, and be a resource to withdraw us from all the daily cares which so often and needlessly perplex us; for the mind cannot at one time be occupied by two objects of sense, or two conceptions, the abiding results of past impressions.

Cicero appears to have had this in his thoughts, and, like Byron, considered "that words are things," since they excite conception,—the chief thing with which all artists, orators, and both scientific and literary men are most conversant. But Mr. Burke seems to have thought that the pleasure which we derive from poetry at least is not by the conception which words, "sparks of immortality," incite. From this opinion, sanctioned as it is by so great a man, an appeal may be confidently made to every one's experience, while reading the odes or elegy by Gray, or the plays of Shakspeare. How could a Garrick or a Siddons have given expressions to the characters they represented but from conceptions excited by words? And still there are many who assert that they derive more real pleasure from the conceptions excited by the words of Shakspeare read in solitude than when they were impersonated by the matchless art of a Siddons or a Garrick. But this pleasure was from the exciting effect of a quicker circulation, the revivifying of nervous and muscular excitability, the sources of health. Why? If the purpose of this life be, as reason seems to indicate, a school in which such habits of intelligence are formed as may prepare the mind for some more advanced state of existence, on this hypothesis it is explicable why such urgent curiosity to know, and to know by doing, should have been given; and when known, why so impatient to desire to communicate to others; for there are often states of ardent excitement, and the acceleration is mostly in accordance with the excited state of the mind. The restoration of Anson's crew, and the garrison of Breda, from scurvy by hope, and from ague by the confiding hope inspired by charms, supply proof of the salutary effects of a moderately excited circulation induced by hope.

Mr. PATTERSON described a plan of aëreating Aquavivaria adopted by Dr. Ball, of Dublin, which had been perfectly successful. It consisted of a blowing apparatus, by which air was introduced by gutta-percha tubes into the bottom of the tank, by means of a common pair of bellows.

Further Memoranda of Observations made in small Aquaria, in which the Balance between the Animal and Vegetable Organisms was permanently maintained. By ROBERT WARINGTON, *F.C.S.*

The first of these memoranda related to experiments made in a freshwater aquarium. As an evidence of the permanency of the balance capable of being established between the animal and vegetable organisms by the introduction of the water-snail or other phytophagous Mollusca, Mr. Warington stated that the same water in which his original experiments were made in March 1849, has been in constant use up to the present time, several fish living constantly in it without disturbance, and that it is now as bright and in as healthy a state as at the first period of its being employed. Again, in a small jar of about a pint capacity, having a single plant of *Vallisneria spiralis* growing healthily in it, and with a few small water-snails as scavengers, he had succeeded in hatching and rearing a young trout. When the fish was able to swim strongly it was transferred to a small aquarium, containing several minnows, when, to his great annoyance, it was immediately seized and devoured. Care should be taken in the aquarium for fresh water to exclude the corum, or freshwater polype (*Hydra fusca*), particularly where certain species of fish are to be preserved, as the minnow (*Leuciscus phoxinus*); for these creatures, insignificant as they appear, after a short time cause their death, and that under most extraordinary circumstances. His own impression as to the mode in which this destruction of life was brought about was, that the hydras, whenever their extended tentacula were touched by the swimming fish, seized on them, stinging them, and thus causing a great degree of irritation. The polypes also were torn from their position by the greater strength of the fish and carried to their places of retreat, where in consequence the mischief was continually accumulating.

The next series of memoranda had reference to the author's observations made in sea-water aquaria, and were in continuation of those read at a former meeting of the Section. He had had progressing very successfully for some time past an experiment with a view to preserving sea water in a perfectly transparent and healthy state without the use of vegetation of any kind, or in some cases even without the use of a scavenging mollusc. The manner in which sea water under such circumstances might be kept in a healthy state was by exposing a very extended surface of it to the action of the air, and at the same time limiting its depth. He described the arrangement he had adopted for upwards of twelve months, by which a very extensive surface of water was submitted to the oxidizing influence of the air, and the fish and crabs, by their continual movements, caused sufficient motion in the fluid to expose a fresh surface to its action, and thus keep up its aëration. But it must be borne in mind that the oxygenation of the water thus effected was a very delicate equilibrium, and the maintaining a healthy condition was liable to be disturbed by very slight interfering causes; nor did he conceive that this method would be applicable, except to such marine denizens as are either of such low organization as to require but little aëration of the water, or to such as the crab tribe and those creatures which delight in frequenting shallow water or have the power of climbing out of their liquid element.

The form of the aquarium which he had now, after upwards of five years' experience and observation of the natural habits of the various animated tenants, adopted, consisted in a four-sided vessel, having the back gradually sloping upwards from the bottom, at an angle of 45 to 50 degrees, and the consequently widened top sloping slightly downwards, and its covering glass resting on the upper part of the back. The bottom, therefore, became necessarily narrow. The front, for the purpose of observation, and the top for the admission of light, were to be of glass, the back, ends, and bottom being constructed of slate; the whole fixed in a stout framework. The sloping back was covered with light rock-work, extending to a short distance above the water line.

On the Application of Photography to the Delineation of Microscopic Objects. By F. WENHAM.

The author described the process which he had adopted, and exhibited photographic pictures of magnified objects, which were remarkable for the accuracy with which the details of the object magnified were represented.

GEOGRAPHY AND ETHNOLOGY.

GEOGRAPHY.

Some Remarks on Levels taken in Jerusalem, with the Aneroid Barometer. By Capt. W. ALLEN, *R.N., F.R.S., F.R.G.S.*

THE authenticity of the traditions that were supposed to have fixed the sites of the Holy Places in Jerusalem, remained unquestioned during nearly fifteen centuries. In this inquiring age, not only have grave doubts arisen on the subject, but there is a disposition in some travellers, who have carefully examined the localities, to reject these traditions altogether; so much are they thought to be at variance with probability, and with the results of their examinations.

The discussion chiefly turns on the line of direction which the second wall, or that existing at the time of the Crucifixion, is supposed to have taken; because it is known that the Jews did not bury their dead within the walls, and there is proof in Holy Writ that Golgotha was outside.

The principal authority for tracing this line is to be found in the description of the city by the historian Josephus, which unfortunately is vague in some respects, so that arguments may be drawn from it for both sides of the controversy.

The present wall of the city is now certainly outside the Church of the Sepulchre, that was built in the time of the Emperor Constantine, and by his orders; but since the question has been mooted, the advocates for the traditions say that this wall was restored by the Crusaders, on the ruins of that of Agrippa, which was built *after* the Crucifixion. Their opponents, on the contrary, affirm this to have been the line of the second wall; which, if true, would bring the supposed Golgotha within the city, and in such case it cannot be the true site.

Without venturing, at present, to give an opinion on the general question, I may say that I carefully examined the line where a late traveller believed he had discovered indubitable vestiges of the ancient, or second wall, turning inwards, so as to exclude the Holy Places. I had his book in my hand, and was assisted by two impartial companions. We came to the conclusion that the remains we were able to find did not justify his assumption.

The arguments of all the controversialists have been taken from examinations of the ground plan of the city. But Jerusalem was built on a very irregular surface; the principal features of which are observable at the present day, notwithstanding the vast accumulation of rubbish, from the ruins of many ages, which have softened their outlines.

A knowledge of the amount and form of these irregularities, or a section of the hill on which the city was built, must be admitted to be an important element in the consideration. I therefore took some levels with the aneroid at several points within the present walls, chiefly from east to west, along the line of the Via Dolorosa, and in the Church of the Sepulchre, which, if not perfectly accurate, may be useful at all events, in default of a more correct method of levelling, to call attention to this important element in the discussion. The following refer to the Temple area:—

There is a small rise near the Governor's gate of	9·6	feet.
The point where the Via Dolorosa crosses the upper part of the Val Tyropæan is below the Temple area	−27·	,,
At the crossing of the Via Dolorosa with the street leading to the Damascus gate above T. A.	+38·5	,,
The pavement of the Church of the Sepulchre	67·5	,,
At the crossing of the Via Dolorosa with Patriarch-street	115	,,
The highest point at the N.W. corner of the city	203	,,

Thus it appears there is a rapid slope from the N.W. corner of the hill on which the city is built, down to the valley of the Tyropæan of about one in six or seven. Therefore the second wall, to have excluded the traditionary site of Golgotha, must have been carried along the brow of the hill, in such a manner, as to have left a steep ascent outside, while within the city would have been in a deep hollow, and would have been so contracted at this part as not to have afforded sufficient space for the immense multitude said to have been assembled in the city at the time of its capture by Titus.

It is difficult to imagine how, with such an admirable site for fortification, an eminence of 165 feet should have been left outside of the wall at a distance of only 400 yards. Such neglect would unquestionably have rendered the west the weakest side of the city, which would not have been overlooked by assailants, who, however, always attacked from the north, where the want of natural defences really left the wall on that side the most vulnerable.

For which reason, I think that the commanding eminence at the N.W. corner of the city must have been included in any scheme of fortification of Jerusalem.

Some Sectional Diagrams illustrative of the Changes in the Bed of the River Mersey and its Approaches. By J. BOULT[*].

On the Site of the Holy Sepulchre at Jerusalem. By J. FERGUSSON.

On Arctic and Antarctic Currents, and their Connexion with the Fate of Sir John Franklin. *By* A. G. FINDLAY, *F.R.G.S.*

Allusion was made to a former paper, read to the Association at Hull last year, describing the currents of the Atlantic and Pacific Oceans, in the latter of which it was thought some new features were described. It was shown that a great similarity existed in the movements of the two oceans, a system of westerly drifts between the tropics, which on arriving at the western side of each ocean turned north and south from the equator on each side of it, and recurving when beyond lat. 30° north and south, they passed to eastward, and re-entering their course on the eastern sides, they formed a complete circulatory system. In the present paper it was shown how the Polar regions were connected with these movements, and how tropical warmth reached the poles, and the cooling effects of the extreme climates were brought into more temperate zones.

It was shown that from the southern edge of the southern connecting current, which flows from west to east around the globe between the latitudes of 40° and 50° S., a system of south-east drifts is found impelled by the prevailing north-west winds. These south-east drifts were traced step by step from the observations made by the United States Exploring Expedition, Sir James Ross, Balleny, D'Urville, Biscoe, Bransfield, Weddell, and others, nearly around the Antarctic Circle, showing the remarkable feature of the whole of the surface waters below 55° and 65° S. setting towards an impenetrable icy barrier, which encircles the South Pole at the rate of from 10 to 25 miles a day. On the illustrative diagram the course of this warmer water was marked by red lines. It was afterwards shown that the return of this water was by *subsurface* or submarine currents setting to the *north-east*, and were marked *blue* lines.

---

[*] The notice of this paper is omitted, because the subject has been referred to a Committee for special investigation.

The nature of the enormous magnitude of the antarctic ices, which offer a perfect contrast to those of the North Pole, was explained. This enormous collection around the South Pole is purely the result of atmospheric deposition, and is remarkable as lying to the south of the greatest area of ocean water on the earth's surface, and over which the winds pass towards it; but from the fact of all countries in south latitude having arid climates, and those in the north the reverse, this was another evidence that the evaporation of the northern hemisphere is deposited in the south, and *vice versâ*.

One fact analogous to those observed in the North Atlantic Ocean,—of dust, once supposed to be volcanic, but proved to be microscopic Crustacea,—was cited as occurring near to the antarctic circle, and also adding a confirmation of the theory of the atmospheric circulation. The face of the icy barrier, consisting of cliffs elevated from 150 to 210 feet above the sea level, perfectly wall-faced, and extending continuously for hundreds of miles, was an evidence that ocean currents did not penetrate that circle, which we only know from its external edge. These table-topped barriers were the result of surface deposition, and, being above 1000 feet thick, were of sufficient solidity to be protruded bodily downwards from the interior lands, which might consist of mountains of solid ice of sufficient inclination seawards to allow the set of the stratified upper portions to glide downwards, bearing on their under surfaces immense quantities of earth and detached rocks.

The floating ice met with in such large quantities is the result of the breaking up of the detached table-topped bergs, and from the face of the cliffs, and not formed on the surface of the sea, which maintained a comparatively high temperature. This high temperature was brought by the south-east current previously alluded to as setting from the southern portions of the south connecting current, and the rates and duration of which were inferred from the examples cited at from ten to twenty-five miles per day. Arriving at the face of the icy barrier this current was lost, close under it there being but little movement felt; what there was being a drift to the *westward*,—a circumstance similar to what has been related north of Siberia. On the surface, then, no outlet is appreciable for the waters, but the drifting of the immense tabular bergs, immersed 800 feet, and rising 200 feet out of the water, was a proof of a northern or rather a north-easterly set, which by different observations was considered to move from twelve to eighteen miles per day when free from the barrier. The zone of equal temperature of the ocean, or 39°·5, was observed by Capt. Sir James Ross to encircle the South Pole in a mean latitude of 56° 26′ south. On this circle the temperature was the same from the surface to the bottom, and was connected with these surface and subsurface currents moving in opposing directions. The icebergs and drift ice being thus transported into more temperate climates, disappear, and the north-east drift adds its share to the eastward currents, which strike the western shores of Patagonia, and then turning northward form the Peruvian current, and against the west coast of Africa forming the cool South African current.

In this manner the frigid influences of the antarctic climate were attempered, and brought into connexion with the other portions of the great world of waters, and illustrated that mighty system of ocean circulation everywhere evident in its effects on climate and the subject of meteorology in general.

In the North Polar Sea a very different order of things exists; in many points a perfect contrast to those just described; but, as the subject was more familiar, it was not so largely entered into, the chief features only being selected.

The fact of the Arctic Basin not being a sea of perpetual ice (or one solid mass of ice), was an evidence that it was pervious to the influences of more temperate climates; and that there being no old ice was a proof that means were at work for renewing it and dissipating the surplus of what the short summer does not dissolve. The current through Behring Strait,—an offset of that which the author first described, in 1851, as the Japanese current, similar in the Pacific to the Gulf-stream in the Atlantic,—was shown to be an unimportant northerly set through the narrow strait, and therefore was quite inadequate to produce any marked effect on the polar ices. The main body of warm water passed between Greenland, or rather Iceland, and Norway, and was an offset to the north-east of a portion of the Gulf-stream. The mode of this drift was explained by a diagram of the winds in lat. 47½° north, long. 32½° west, derived from Commander Maury's observations, but which showed some imperfections in the recording or arrangement. In this the great prevalence of the south-west over the north-east winds was clearly seen; and to this was owing the drift, which renders England and Iceland habitable, and enters the Arctic Basin, as has been described. The course of this stream was then traced step by step, eastward, till it emerged into Baffin's Bay or north of Greenland, between it and Spitzbergen, whence, passing southwards, it joined the southerly set down Baffin's Bay, across the banks of Newfoundland, transporting the deeply-immersed bergs into the warm waters of the superficial Gulf-stream, and then, turning to the south-west, between the Gulf-stream and the coast, it was lost as a surface current at Cape Hatteras.

In the north, then, as well as in the south, the circulatory system is apparent, and thus each portion of the waters of the ocean visits, by turns, every portion of the earth.

The fate of Sir John Franklin was next brought forward as a collateral subject. Mr. Findlay held that the statement that two deserted and dismantled ships, seen on the ice on the north edge of the Newfoundland Banks on April 20, 1851, was quite possible, and that if true, of which he had no doubt, they were the unfortunate 'Erebus' and 'Terror.' The perfect consistency of the story as related by the different parties whose testimony had never been shaken by the strictest investigation, and the improbability of any whaling-ships remaining perfect for many years, led to the conclusion that they could be no other.

From the preceding observations, it was shown that there was a constant set of the current out of Baffin's Bay and the inlets connected with it to the southward, and that all floating bodies, including the ices which the summer's heat would not dissolve, would be drifted into the more temperate regions south of Labrador and Newfoundland, or else be forced on to its shores. The strict but fruitless search precluded the latter opinion. Supposing then that the 'Erebus' and 'Terror' had proceeded up Wellington Channel and Penny Strait, as was then fully believed, it was considered quite possible that they, being abandoned, might be again drifted through Smith's Sound or round Greenland into the position of the deserted vessels seen on the ice, a theory much more easy of belief if they had not passed beyond Lancaster Sound. The possibility of such a circumstance was held from the analogous cases of the drift of Sir James Ross out of Lancaster Sound; of the 'Terror' being caught and forced out of the water in 1837, and remaining 118 days fixed in the ice; of similar cases cited by Dr. Scoresby, one of which, a Dutch ship in 1777, drifted 1300 miles to the southward in 108 days and still preserved; and more important still, the drifting of the Grinnell Expedition out of Barrow's Strait, in 1851. The piece of a boat's mast and a boat's awning stanchion, picked up by Dr. Rae on the south-east coast of Wollaston Land, was confidently believed to be a portion of the Franklin Expedition, and would entirely agree with what had been previously stated.

It was thought that if the present expeditions returned without gaining any intelligence that the subject would remain shrouded in mystery, and the explanations here given might be taken as the only solution of this painful enigma.

Despatch from Acting-Consul GABRIEL *to* Lord CLARENDON, *announcing the arrival of* Dr. LIVINGSTON *at Loanda, on the West Coast of Africa.*

"My Lord,—I have much pleasure in acquainting your lordship that the Rev. David Livingston, who set out from the Cape of Good Hope, in May 1852, for the purpose of exploring the interior of Southern Africa, arrived at this place on the 31st ult., after having, with the most inadequate resources, traversed the interior of this continent between the meridians of 23° and 26° of east longitude, as far as 9° of southern latitude. Mr. Livingston sojourned about eight months in the country of the Yambeze, lying in the centre of the continent, between the parallels of 14° and 18° of south lat., where he appears to have been received in the most amiable manner by Sekeletu, the paramount chief, and during that time he seems to have laboured diligently in propagating the Gospel and attaining a knowledge of the country and its inhabitants. He started from the capital of Seketu, on the margins of the River Cholé, in lat. 18° 17′ south, and long. 23° 49′ east, in November 1853, accompanied by seventy-seven of the natives, and a sufficient number of oxen for the journey, which he obtained from that chief. Ascending thence one of the branches of the river Yambeze, which flows through a portion of the Balonda country, he proceeded westward, and entered within the limits of this province at Cassangé, in lat. 9° 37′ 30″ south, and long. 17° 43′ east, having experienced considerable obstructions from the native tribes with whom he came in contact as he approached the Portuguese territory. From Cassangé he followed a direct course to Loanda, and travelled through some of the most important Portuguese settlements in the interior of Angola, receiving every facility from the Portuguese authorities through whose jurisdiction he passed. The adventures and discoveries of this enterprising and energetic traveller will doubtless be laid before the public in due time; but I hasten to report to your Lordship the interesting fact of his arrival at this place, feeling assured that it will be gratifying to you to hear of the movements of a gentleman, who, notwithstanding all the dangers and difficulties which surrounded him in travelling amongst a people who had never seen a European before, and treading on grounds the knowledge and true position of which had been hitherto wholly unknown, has, by his own personal exertions and dauntless courage, done so much to enlarge the bounds of geographical science. I have the honour to enclose herewith the official bulletin of this province, containing a short announcement of the arrival of Mr. Livingston,—a translation of which I also beg to subjoin. Mr. Livingston's health has, I am extremely sorry to say, suffered severely since his arrival at this place; but he, notwithstanding, seems resolved to proceed on another tour of discovery, as soon as the state of his health and other circumstances will permit. I have read this despatch to Mr. Livingston, whose illness will prevent him from preparing any report of his movements for transmission to England by the present opportunity. That gentleman requests me to add, for your lordship's information, that it is with peculiar satisfaction he has learnt since his arrival here of the efforts now making by Commander Bedingfield, of Her Majesty's steam-vessel Plato, to open up a commercial intercourse with the chiefs of the Congo, because in the course of his travels, he crossed the river Casai, flowing N.N.E. and N.E., and the Urango [*sic*] flowing due north, which are reported by the Portuguese traders in the interior as well as by intelligent natives, after watering an immense extent of well-peopled country, to form, by their junction, the River Zairo or Congo. Mr. Livingston is of opinion, that if legitimate commerce were once established in the Congo, there is a high degree of probability that the slave-trade would be effectually checked throughout the whole extent of that country. I have, &c.

"EDMUND GABRIEL."

"Loanda, June 22, 1854."

On the Shortest Routes to South Australia. By Capt. S. GALE.

Remarks on the Lake Aulaga and its Drainage in the Desert of Caranjas, in Bolivia. By MATHIE HAMILTON, *M.D., Glasgow.*

This paper was illustrated by a diagram of the author's route across the southern portion of the Great Valley, or table-land of Bolivia, between the eastern Cordillera and the snow-covered mountain of Sahama, on which two nights were passed more than 16,000 feet above the ocean.

After three days' travelling from Potosi on the eastern Andes, in a south-west direction, the party, which numbered seven men and thirty-eight mules, descended to the valley of the Marquis, which on the west is bounded by a ridge or spur of the Andes, having along its eastern base a stream called the river of the Marquis, which runs south; it originating in the bifurcation. This ridge is some leagues long, and terminates abruptly in a ledge of water-worn rocks about 100 feet high. The valley extends south beyond the termination of the ridge, showing a *cul-de-sac*, which is formed by the bifurcation of the eastern from the western Cordillera, which was distinctly seen by Dr. Hamilton while doubling the ridge on the 7th of November; on the 8th a river flowing from the south was passed, which at that date was only a few paces wide; but judging from an expanse of alluvial mud, that stream during the rainy season must be as broad there as the Thames at Hampton Court, and discharges much water into the southern extremity of Lake Aulaga, or Aliaga, *i. e.* the furze-bush or whin lake. It is so named from a stunted prickly shrub, a species of the *Ulex Europæus* of Linnæus, which grows near the lake. That shrub and the dried droppings of the Alpaca tribe is the only sort of fuel obtained in this desert. Lake Aulaga extends about sixty English miles from north to south, with an average breadth of fifteen, but towards its southern margin it is about seven Spanish leagues, or twenty miles across from east to west, and on the north it receives the surplus water of the Great Lake Titica*h*a, which has only one outlet, the Disaguadera, or drain, which runs a course of 200 miles to Lake Aulaga. Much water is discharged from Titica*h*a into the Aulaga at all times of the year, but during the rainy season there, from January till March inclusive, the quantity is very great. The distance by this route, from the valley of the Marquis to the mountain of Sahama, is about 250 miles, which required eight days, as the mules were loaded with thirty quintals of silver. Myriads of Llamas and Alpacas were seen, but water was not obtained except at a few spots in holes which have been dug to retain surface water which falls during the rains. On the 10th of November the Indian village of Andamarca was passed, which consisted of about fifty huts, situated on a gentle slope, on whose summit grew a row of the *Cactus Peruviana.* The Curate stated that the distance between Potosi and Andamarca is about sixty-seven leagues, and from that village to Tacna eighty-four leagues. The only language spoken in Andomarca is the Ayamara, which is more euphonous than the Quichua, that which is used by Indians in Potosi and generally in Bolivia and Peru.

On the 11th the guide gave notice that water would not be found at night, so that it was carried a journey of forty miles for the men, and on the 12th, after five hours' travel, a stream was crossed, the water being good and flowing to the south-west. It is one of the drains of Lake Aulaga, termination unknown; on the morning of 13th the snow-capped mountains of the western Andes were seen for the first time on the journey from the interior, and was a welcome spectacle, for both mules and men were suffering much from want of food and water, and were still eight days' travel from the coast: this day another river was passed, it also flowing towards the south-west and distant about thirty miles from that of yesterday. The water was clear and good, moving one and a half or two miles an hour, over sand and gravel, with a breadth of about 20 feet, and the depth such that a long-legged mule, when in mid-channel, was above the knees in water.

This nameless river is the principal drain of Lake Aulaga, and through it, of the great Lake Titica*h*a. The termination of this stream is still a mystery, though during the wet season in those elevated regions much water is conveyed through its channel towards the western Cordillera. On the 14th, the plateau of Sahama was reached, which, with its dome-shaped summit, was under snow, where the party passed the night in the open air, distant about fifty miles from the place where the river was crossed. Though a countless number of Llamas and Alpacas were seen in the Desert, yet not a creature of any other kind was observed; and excepting those in the village of Andomarca, only four human beings were seen on the journey from Potosi to Palka, which, by the unusual route that was taken, is about 450 miles.

Extracts of a Letter from the Rev. Dr. Livingston *to the* Rev. Arthur Tidman, *D.D., dated Town of Sekeletu, Linyanti, 24th September,* 1853. *Communicated by* Dr. NORTON SHAW.

"When the obstacles which caused our detention at Kuruman were removed, we passed quickly towards the country of Sebituane, until within one degree of latitude from this town. All the people were then suddenly laid prostrate by fever, except of one lad and myself. This caused a further loss of time, but, through the goodness God, all recovered. On reaching this, the southern capital of the Makololo, we were received with all the demonstrations of welcome which they are accustomed to bestow on their chiefs. We embarked on the river called everywhere Leeambye, at the village of Sekhosi, our fleet consisting of thirty-three canoes, and our company of about 160 men. From the bend at Katima-molelo up to the commencement of the Barotsey valley, the country is covered by forest and tsetse. Many villages of Banyeti, a poor but industrious people, are situated on both of them. They are expert as hunters of hippopotami and other animals, and cultivate grain extensively. Passing beyond these parts, the high banks seem to leave the river and stretch away to the N.N.E. and N.N.W. until between twenty and thirty miles apart; the intervening space, 100 miles in length, is the Barotsey country, and this is annually inundated, as Lower Egypt is by the Nile. The valley is covered with coarse succulent grasses, which are the pasturage of large herds of cattle during a portion of the year. There are many villages of Makololo in the valley. I have not put down all that I visited, and many were seen in the distance; but there are no large towns. The reasons are, the mounds on which alone towns and villages are built are all small, and the people require to live separate on account of being rich in cattle. Nariele, the capital of the Barotsey country, does not contain 1000 inhabitants. We went north till we came to the junction of Leeba or Londa with the main stream Leeambye, in 14° 11′ south lat., and found the country presenting the same characteristics as I have described. On returning towards Nariele, I went to the eastern ridge in order to examine that, and see the establishment of a merchant from the furthest inland station of the Portuguese, opposite Benguela. A stockade had been erected, and a flagstaff for the Portuguese banner planted. The houses of the merchant and some bastards were in the West African style. The owner, whom I had previously seen at Linyanti, was absent; but his servants did their utmost to show me kindness. When my boatmen prepared my bed outside, they insisted on my occupying their master's couch; and I never felt so grateful in my life for a warm shelter, for I was in the cold stage of one of the intermittents, which continued to plague me after the fever. I thought of going westward in company with this merchant, but the sight of gangs of poor wretches in chains at the stockade induced me to resolve to proceed alone. I have not, I am sorry to confess, discovered a healthy locality. The whole of the country of Sebituane is unhealthy. The current of the river is rapid as far as we went, and showed we must have been on an elevated table-land; yet the inundations cause the fever to prevail very extensively. I am at a loss what to do, but will not give up the case as hopeless. Shame upon us missionaries if we are to be outdone by slave-traders! I met Arabs from Zanguebar, subjects of the Imaum of Muscat, who had been quite across the continent. They wrote Arabic readily in my note-book, and boldly avowed that Mohammed was the greatest of all the prophets. But for the destruction of my celestial map by the Boers, I might have determined the longitude by occultations alone, they being much more to be depended on than the common method of lunar distances. If, then, I am right, we are nearer the west than the east coast. Nariele is in 23° east, and the confluence of the Leeba or Londa not much more. I have not had time to work out the longitude of that point; but the river (Leeba) comes from the capital of a powerful state, whose chief is reported to be friendly to foreigners. If I am permitted to return by the chieftain, it will be water-carriage for perhaps two-thirds of the way: and should a mission be established there in time, it will be all the better. I intend to try for Loanda, because, though farther, many English live there. I go on horseback, waggon-travelling being reported impossible on account of forests and numerous rivers. The Portuguese are carried in hammocks hung on poles—two slaves carry a man—but it does not look well. The Portuguese maps are all constructed from native reports, so no dependence can be placed upon them. Many tribes inhabit the country, all more or less accustomed to the visits of strangers. The greatest difficulty, I apprehend, is that of making our objects understood. Their languages bear a close affinity to the Barotsey dialect; but this I was compelled to give up reducing. The country in the direction of Mosioatunya has high mountains, and the Batska country is a high table-land, without trees except along the rivers. Healthy spots may be found in both of these; but in neither did I feel it my duty to travel, because the vicinity of Mosiltkatse renders it impossible for Makololo or any other tribe to reside there. A change may yet be effected among the Matibele, which would change the present aspect of affairs."

On the Eastern Territory of the Ecuador and the River Napo. *By the* Rev. C. G. NICOLAY, *F.R.G.S.*

The object of this paper was to show the commercial value of this territory to Great Britain, and its accessibility by the river Maranon and the Napo. It stated that all the upper waters of the Napo are auriferous, especially the Arapuno, Anzupi, Aguarico, and the Payanino, the latter being by far the richest; the Coca and Napo also abounding in gold, which is found not only in auriferous sands, but *in situ* in large quantities. The vegetable productions of the country were also stated to be most valuable, comprising cinnamon, from which it was originally named canelos, sarsaparilla, cocoa, tobacco, rice, indigo, vanilla, and the agave or pita now shown by Dr. Royle to be so valuable in manufactures. Seventeen villages of domiciliated Indians were enumerated, who were said to be of industrious habits, docile and gentle, numbering 6850; the wild Indians very numerous, but not dangerous.

The rivers, which will admit of steam communication at present, are the Napo, Coca, the Curaray and Pastaza; and the head of this navigation is connected by a cross road, in continuation of an old road of the Inca's, extending from the Pastaza on the south-west, to the Coca on the south-east.

Extracts of a Letter from the Rev. J. Rebmann *to the* Rev. H. Venn, *dated Kisaludini (in Rabbai), April* 13, 1854. *Communicated by* Dr. SHAW.

"Of that preparatory work mentioned above, which I have been engaged in this half-year, I would first mention the gathering of a vocabulary of the Kiniassa language, which I have now carried to the letter M. I need scarcely say, that it also belongs to the great South African family of languages. Sounds which we have not yet met with in other dialects are "pf" and "ps," or "bs," for the latter of which I have chosen the Greek ψ. My informant is a slave from Mombas, who came into our service before I knew anything about his origin, which I rather accidentally discovered when I heard him once speak to one of his fellow-servants in a strange dialect. On inquiry, I was told that he was an M'niassa, who, in consequence of international expeditions for slave-catching, was seized by a tribe called Wapogera, who sold him to the Wamarávi, and these to Suaheli slave-merchants, who had come from Uĭbu (a small island belonging to Mozambique, and on the maps called *Ibo*). At Uibu, which was reached after two months' travelling at a very slow rate (in effective march only half the time is wanted), he was at last bought by slave-merchants from Mombas. This he thinks happened about ten years ago, while he is now a man of about thirty years of age. The remembrance of his country and language can therefore be well supposed to be very distinct. His native territory he calls Kumpande, two days west from the lake which, by the tribes who live on its banks, is called Niansha (or Nianja), of which the Suahelis evidently made Niassa. He states that he used to go very often to the lake in search of mia (pl. of mũã), a species of palm, of the leaves of which the natives make mats, bags, &c., as also to buy cotton, which is grown near the lake, and of which they weave a coarse kind of cloth; while their better articles of clothing, as also their beads, brass wire, and especially their guns (called "fuds" in their language), they buy from the Portuguese, who seem to have some settlements at no great distance from them, called "Kubāle" and "Kumkōma." The Portuguese are called by them "Wakigunda," while the name generally given by the East Africans to Europeans is "Wasunga." From that part of the lake's banks, he used to come to from his home, the opposite side cannot be seen, but a boat starting at daybreak will reach it at sunset. Their boats are, however, not provided with rudders, wherefore they only use oars. Following the margin of the lake to the south, through the territory of Marávi, for a few days its breadth seems gradually to decrease, till, as my informant expressed himself, people on the one side are within call of people on the other side; but of its extent to the north he and his countrymen have no idea. They only know that it gets much broader there than it is with them; so much so, that they are deterred from fording it, because they lose sight of the banks, and therefore only go to neighbouring islands for fishing. During the cold and rainy season the lake is said to be extremely boisterous, but during the hot season quite calm.

"When my informant spoke of the cold in his country, he described the water as getting a hard crust during the night, which of course can be nothing else but ice, called 'kungu' in their language. This, however, is only found in small collections of standing water (and never in the lake Niassa). The Wakiáo (not Wahiau) are spread on the eastern banks of the lake; to the south and south-west are the Wamarávi; and north from these the Wakamtunda, of whom the Wakumpandi and Wapogéra are only subdivisions. The name Marávi, which in older maps is given as the name of the lake, I had never heard before from a native. Salimini, my informant, never applied it to the lake, but to a large territory bordering upon it, and in part forming its south-western banks. The occupants are called Wamarávi; and these, together with the Wakamtunda, and perhaps still the other tribes, are, by the Suahelis on the coast generally, comprised under the common name Waniássa. The Wakamanga, whom, on the map of 1850, I have placed to the east of the lake, are, according to Salimini, to be placed even to the west of the Wakamtunda, to whom they stand in the same relation as the Wakamba to the Wanika. He also mentioned a large river to the south of his country, which he called Temba, and the people living on its banks Watemba. Temba may be identical with Tembo, about half a degree south of Ibo (Uïbu). [See W. Keble's map of Africa, published for the Christian Knowledge Society.] In the vicinity of the Watemba are the Wanzunsi, who, from an abundance of iron in their country, seem to be the principal blacksmiths among all the tribes around. On being applied to for hoes by people who have come from a distance, with a cow or goat for their barter, they will work all the night at their fires."

Hydrographical Remarks on the Improvement of the Port of Liverpool. By George Rennie, *F.R.S.*

On the Caucasus and Parts of the Crimea. By D. Seymour.

Mr. Seymour passed through the Crimea nine years ago, and spent one summer there; in Circassia he spent three years, and visited it at two different times before, and after a long journey in Persia and India. The Crimea contains four races of people; amongst whom are the Tartars, the great bulk of the population; the Greeks, many remaining of the old Greek colonies established there; also an ancient colony of Jews, near Simpheropol; and lastly, the Russians, who had gone there in great numbers since the country came into their possession, about the year 1786. He referred to Perekop, which, he said, was a cold climate, little cultivated, and containing hardly any Russian population. The steppes and plains were similar to the Downs in Wiltshire. Thence there were slopes all along the country until approaching Simpheropol, near the centre of the island, and scarcely a tree or landmark to intercept the view. The plains then rise gradually on approaching Simpheropol, where the mountains are visible, and there are little undulating hills after passing that town. It is a pretty Russian town, with good houses, surrounded by woods, and is principally inhabited by Russians. To the south-west, about forty miles, is Balaklava, where there is a beautiful remnant of old Moorish architecture, the palace of the old Khan of the Crimea; near that, in the mountains, is the colony of the Jews before alluded to. They are that section of the Jews who rejected the interpolation of the Talmud. Leaving Balaklava, he visited Sebastopol.

After contrasting the southern with the northern portion of the country,—which he described as being different in their climate and general character,—he referred to the Tauric chain of hills which rise from the sea in a most delightful slope, on which the rich Russians come and spend the summer. With regard to Odessa, it was a place destitute of attraction in respect to climate and other circumstances; in winter the cold was extreme, arising from certain winds, and in summer the clouds of dust were such as to render it almost uninhabitable. The southern coast of the Crimea was protected from the effects of these winds. There was good vegetation on the slopes of the hills, and the vine grew in large quantities. He had heard at Kertch that a portion of the wine produced there was sold in Europe as an inferior kind of port and sherry.

Mr. Seymour afterwards returned to Simpheropol through the mountains. All the southern parts of the Crimea are covered with stone tumuli and other remnants of successive generations of Greeks who had lived there at a very remote period. After describing Kertch, a new place, now one of great resort and much frequented by shipping, he crossed the straits which divide the sea of Azof from the Black Sea; this was the Cimmerian Bosphorus, where the ancients placed the entrance to the infernal regions. The general geography of that part of the world had altered much since it was mentioned by the ancient Greek geographers, and there were now no flourishing cities, temples, or monuments. After glancing at some of the ancient traditions connected with the localities he had visited, he directed attention to the country lying on the shores of the Black Sea to the east, which was extremely beautiful, and rich in vegetation, bearing a strong resemblance to the coast of Malabar. The southern shore of the Caucasus was also one of those favoured regions for the growth of shrubs and plants, and considered extremely fertile. All that country now occupied by the Russians, with the twelve forts, all of which had been abandoned, except Anapa, those on the lower southern range of the Caucasus, and the lower ridges of mountains, as far as Georgia, were inhabited by the people known as the Circassians. After tracing the different races of the Caucasus, and showing their origin, the speaker referred to the power of Russia in that country, observing that she only possessed the ground on which the forts were built, and there was difficulty in obtaining sufficient food to support life. The forts on the east coast of the Black Sea were reserved as a sort of Norfolk Island for the army, and all considered as going too quick in the march of progress were sent to finish the short remains of their existence in that country. Such was the mortality, that the whole of the troops had to be renewed in about five years. Those who went there seldom came back again, and the regiments were not relieved, but left there until they died.

Attempts had been made by Russia to gain the confidence of the Circassians, and even Greek priests had been sent there by the Emperor to induce them to become converts to the Greek Church, but hitherto those attempts had been unsuccessful. After describing the country of the Black Sea Cossacks, commencing at Kamarne, Mr. Seymour referred to the Russian territory in that direction, more especially the steppes, which, he said, contained a rich loamy soil, only requiring cultivation by the hand of man to produce large and luxuriant crops. In Circassia the Cossacks were kept in a continual state of alarm by their enemies the Circassians; they were always on the alert, and if any danger appeared they placed a torch to some straw of combustible material; this was a signal conveying the intelligence down the line, by which 3000 or 4000 men could be summoned when the Circassians were likely to surprise them. The Cossack dress so much resembled that of the Circassians, that it was almost impossible to distinguish them; and, as regarded personal safety, it appeared that every man was obliged to be constantly on the alert to save his life. The Russian army in the Caucasus, when he (Mr. Seymour) was there in 1846, was 170,000 men; but a portion of them were always to the north of the Caucasus, the main part being concentrated to the left of Stavropol.

Extracts from the MS. Notes of Travels of General Fevrier *in Central Asia, from Teheran to Herat, Balkh, Candahar, and along the course of the Helmund and round the Lake Sistan. By* D. SEYMOUR.

Communications on an Australian Expedition, from Capt. CHARLES STURT, Dr. J. W. F. BLUNDELL, *and* G. S. WILSON, *Geologist to the Expedition.*

Capt. Sturt says his conviction is, from extensive observation, that there is a great inland sea, almost due south from the Victoria river. He crossed, when there, a stony plain, on which there was no vegetation, and another plain covered with sand. These places were the lowest land he could see; and the general dip of the country was from east to west. These earthy places frequently became covered with water; and, the fall being to the west, he asked, where did those waters accumulate? The contemplated expedition would perhaps let us know whether there was any communication between the Swan River and the interior. Capt. Sturt thinks that a rich country will probably be found in the north, judging from the flight of some birds, and the vicinity of hills, between lat. 16° and 20°, and long. 120° and 133°. Dr. Blundell's communication spoke of the necessity of any expedition proceeding from the north.

On Glaciers in the Arctic Regions. By Dr. SUTHERLAND.

On Modifications of Great-Circle Sailing. By J. TOWSON.

On the Estuary of the River Mersey, and the hazardous and uncertain Approaches to the Port of Liverpool. By J. B. YATES, *M.A., F.S.A.*[*]

ETHNOLOGY.

On South African Languages. By Dr. BLECH.

A Description of Three Esquimaux, lately exhibited in London.
By RICHARD CULL, *Hon. Sec. Eth. Soc.*

On the Ethnological Value of the Results of Philological Inquiry.
By RICHARD CULL, *Hon. Sec. Eth. Soc.*

Notes on the Etruscan Question. By WILLIAM FREUND, *LL.D.*
Communicated by RICHARD CULL, *Hon. Sec. Eth. Soc.*

After travelling through, and my sojourn in, the country supposed to be the original home of the Rasenas or Etruscans, and after having studied the language of the district, and examined the remains of antiquity, I venture to lay down the following positions as results of my researches:—1. The statement of Pliny, book 5, chap. 33, "The Alpine nations, who have without any doubt this (Etruscan) origin, more especially the Rhætians, whose situation has made them savage, so as to retain nothing of their original except the sound of their language, and not even that without corruption," is to be received as true history. 2. The immigration of Etruscans from Upper Italy into the Rhætian Alps, when pressed by the Gauls, as related both by Pliny and Justin, is by no means impossible, but is probable; and, therefore, their statement is credible. The open Alpine side valleys on the north of the wide plains of Upper Italy offer themselves as places of refuge to the conquered and dispossessed Etruscans. 3. The aboriginal Rhætians and Etruscans belong neither to the Germanic nor to the Celtic race, but are a separate branch of the great Indo-European family. 4. The question of their relationship to the ancient Iberians of Spain is not yet sufficiently investigated. 5. The Rhæto-Romanish language, as in the literature of the Grisons, and the speech of the Rhætian Alps, contains about one thousand words, especially belonging to Alpine life and occupation, the origin of which is not German, nor Roman, nor Celtic. 6. These special Rhætian words give us no material for a satisfactory explanation of the Etruscan inscriptions. Etruscan antiquities have been found in the Rhætian Alps: the late Count Giovanelli collected them for years, and bequeathed his collection to the city of Trento in the Tyrol, where they are placed in a museum for the study of the antiquary. Prof. Sulzer, of Trento, gave me copies of prints of two remarkable Etruscan antiquities. [Fine lithographs of the antiquities were exhibited.] 1. A brass pail, found in 1828, on the Hill Caslyr, near Cembra, a small town north of Trento, is deposited in Count Giovanelli's museum. 2. A brass figure, found in the Val di Nôn, near Meran, is in the Trento Museum. There is a remarkable tradition in the Grisons of the immigration of the Etruscans into the country. It is thus related by Campbell, in his 'History of the Grisons':—When, in the summer of 1554, Sienna was occupied by Peter Strozzie, in the name of the king of France, and was besieged by Papal and Florentine troops, the king of France demanded from the Grisons 3000 men for his army. This contingent was to go to the relief of Sienna. The Grisons, however, expected but little success from this plan; for, since the remotest times, there was a deeply-rooted belief that any expedition which caused the descendants of the old Rhætians to cross the Po into Etruria would be unlucky, because the Etrurian territory was their ancestors' home, from which they had been expelled, and that the proposed expedition would be much more unlucky, as it was to be undertaken for the French, whose ancestors, the Gauls, had displaced the old Etruscans, and occupied the country as long as Gallic tribes remained in existence. The National Assembly at Davos declined to raise the contingent, and gave the French ambassador as a reason the above statement.

---

[*] The notice of this paper is omitted, because the subject has been referred to a Committee for special investigation.

On the Forms of the Crania of the Ancient Britons.
By JOSEPH BARNARD DAVIS, *M.R.C.S. Eng., F.S.A.*

These remarks are chiefly founded upon the skull of an ancient Brigantian (?) Briton, derived from the Green-Gate Hill Barrow, near Pickering, and belonging to the "stone period." An observant eye is able to discriminate between natives of the different provinces of the same country, therefore a more comprehensive investigation of the bones of the face and head will lead to reliable conclusions respecting their specific forms. By extended observation, by keeping close to the teachings of the physical phænomena, and by regarding the information to be derived from history, philology and antiquities, more as illustrative and accessory, we may hope to obtain more definite and conclusive knowledge. In explanation of the uncertainty in which the subject is at present involved, it may be remarked—1. *Data have been inadequate.* Browne, Faussett, Douglas and Hoare almost wholly disregarded osseous remains, which are even now mostly rendered valueless by the want of instruction in barrow-diggers. From a scarcity of authentic data, observations have been disconnected and immature. 2. *Study has been too much separated from that of human skulls in general.* Taken up more as an antiquarian than anatomical or ethnological inquiry. 3. *Little attention paid to discrimination of sexes and ages.* Some archæologists of great learning have entirely passed these over, yet the cranium undergoes important modifications in the course of development and growth, not ceasing even in old age. These changes render it necessary to select examples from the middle and mature season of life. Attention to sex is of even greater moment, as, if disregarded, errors may be induced extending to an entire class. The skulls of women seldom exhibit the normal and characteristic ethnic features markedly, and should be employed sparingly. 4. A prolific source of error consists *in overlooking the great diversities of form which present themselves regularly in every family* of the European races, and assuming that we shall find the cranial character more stereotyped as we ascend to primitive times. This assumption has probably led men of great distinction, upon slender evidence for the difference of antiquity of certain skulls, to refer them to a succession of races. A pleasing speculation, but more satisfactory grounds seem to be required for its establishment. 5. *More definite views that prevail on primæval antiquities have dissipated certain preconceptions* concerning cromlechs and kistvaens, and the rites to which they were destined; have proved that cremation and inhumation were practised contemporaneously from the earliest periods; and that the doctrine of the mineral ages of stone, bronze and iron, if not received too exactly and employed too readily in solving difficult problems, is in the main true. Probably until these advances had been made in archæology, the study of ancient crania could not have been profitably undertaken.

From these impediments it must not be inferred there are no fixed principles in the investigation. For,—1. Although it must be admitted there is considerable diversity of form amongst the crania of even one people, ***extensive observation enables us to perceive the general characteristic marks which appertain to them.*** These usually exist, and when duly elaborated, impart stability to our views. 2. If we regard the unity or diversity of origin of the human race as one of the arcana of nature, enshrouded in primæval obscurity, whether wholly impenetrable or not, we are constrained to admit that ***marked dissimilarities have existed from the most remote periods.*** This must be regarded as one of the established postulates of our science, without which it could have no sure foundation. 3. Another equally essential is ***the law of permanence of ethnic forms***; that the characters impressed upon races are not transmutable, but constant. This law has been the subject of much controversy, but the facts adduced against it appear too dubious, unimportant and few to shake its stability; a stability uniform with that observed in all the other divisions of nature, and not to be successfully assailed by the hypothesis of development.

The best course to be pursued in the study of the ancient British skull is to determine the ***normal form***, and then to ascertain the usual deviations from it. This simple method, which has been employed in the elucidation of other natural objects, will reduce the subject to as great order as it admits of, and render description and delineation easy to be understood. A knowledge of the general character of the British skull is not to be obtained from the examination of those belonging to one tribe only, but from a comparative investigation of crania derived from many. In this view, it is believed the Green-Gate-Hill Barrow skull exhibits the true ***typical form*** of the ancient British cranium. Its most marked distinctive features are, the shortness of the face, which is, at the same time, rugged with elevations and depressions, the indications of wild passions operating on the muscles of expression; zygomatic arches not unusually expanded; the nose short, projecting at an angle too great to be graceful; immediately above its root rises an abrupt prominence occasioned by the large frontal sinuses, which passes on the sides into the elevated superciliary ridges, and produces a deep depression between the nose and forehead, giving to the profile a savage character; the osseous case for the brain upon the whole not large, rather than small; the occipito-frontal diameter somewhat contracted, and parietal diameter good. It ranges with the ***orthognathic*** crania, or those having upright jaws, and inclines to the ***brachy-cephalic*** division. It presents the uncivilized character, but from the mass of the brain it has evidently belonged to a capable savage, possessed of power, and fitted to profit by contact with men of other races.

Having thus enumerated the chief peculiarities of the ***typical*** British cranium, we may advert to its leading ***aberrant forms***, which admit of being arranged in a simple intelligible method. They will be easily understood as the ***abbreviated***, or strictly ***brachy-cephalic***; the ***elongated***, or ***dolicho-cephalic***; the ***elevated***, or, to continue the terms, the ***acro-cephalic***; and the ***expanded***, or ***platy-cephalic***. Notwithstanding these aberrant forms, the whole series bears the impress of so many similar features, as to show that it constitutes one natural group. The dolicho-cephalic has been supposed to indicate an "Allophylian" or "pre-Celtic" race, but it may probably be regarded as more properly a family peculiarity in some cases, and accidental in others, in which it has been met with in the same Barrow, and in a position proving the interment to be equally ancient, with a calvarium of the normal form. Stress has been laid upon the circumstance that it has occurred in ***Chambered Barrows***, resembling the famous one of New Grange. The best informed antiquaries accord to these Barrows an extremely early date; but that they have altogether preceded simpler and ruder sepulchral cairns, and were erected by a distinct antecedent race, appear to stand in need of much confirmatory evidence before they can be admitted with tolerable confidence.

In the sepulchral Barrows of our native land we find the invaluable corporeal relics of an ancient race, especially the bony casket which contained the nervous centre of relations between men in all ages; and, if these relics be carefully studied, we have reason to hope we may learn much more of the ethnology of the ancient Britons.

On the Ethnology of the Liverpool District, with Notices of the Hoylake Antiquities. By the Rev. ABRAHAM HUME, *D.C.L., LL.D., Liverpool.*

The author noticed, first, the physical features of the district, remarking that, from the extent of forest and marshy ground, the proportion actually inhabited was comparatively limited. This was mainly along the sea-coast and river margins, as well as in villages, and along leading lines of road. Great part of the hundred of Wirrall was uninhabited, and in Lancashire, the low-lying district to the north of the town. In the Roman times, the Brigantines inhabited Lancashire, and the Cornavii Cheshire. Afterwards, the Saxons dispossessed both; and in 894 the Danes seized Chester, but were expelled by Alfred, and forced to retreat through North Wales. The names of places are interesting, as Inch and Llandegan, words from the ancient British, and Mackerfield in Lancashire. The last word was originally Maeshir, or the Long Field, but the Saxons not understanding it, added feld or field. The Danish names of places lie along the water-side, as Pensby, Irby, Frankby, Greasby, Kirkby (West), Kirkby in Walley (Wallasey), Kirkdale, Crossby, Formby. The Saxon names are found further inland, as Bebington, Woodchurch, Upton, Everton, Litherland, Thornton. Mersey, Tranmere, and Bolton-le-Moors have a Norman form; while Up-Holland, Down-Holland, and Pilling-moss refer to the ancient condition of the district. The principal illustration, however, of the tribes of population which had passed over the district, consisted of the Hoylake articles, found below high-water mark, near Leasowe Lighthouse. In size they embrace literally every object from a needle to an anchor; in antiquity they range from the most primitive periods to the time of George the Third; in art, they comprehend every variety, from the most simple aid for human conveniences, up to objects of great artistic interest. They illustrate the pre-historic, the Celtic, the Saxon, the Danish, the Norman and mediæval periods, but especially the Saxon time and people. It so happens that Hoylake was a line of communication, near two important rivers; and when Chester began to decline as a port, it rose for a time into great importance. Nearly 3000 acres of land in Bidston Marsh are below high-water level, and the sea tries to recover its own again. An entire village has been swept away, and the sea-beach has exhibited various aspects from 1771 to 1772, again to 1813, and to the present time. The objects consisted of celts, objects in bone and horn, heads for bolts and shafts, pheons, keys, fish-hooks, spoons, needles, needle-cases, a gun-rest, crosses, rings in great variety, scissors, buckles, tweezers, fibulæ, amulets, bones, coins whole, halved and quartered, seals, palmers' tokens, a comb, an axehead, &c. The whole of them were exhibited with the Faussett Collection on Wednesday evening, the 27th.

On the Lost Tribes of Israel. By JAMES KENNEDY, *LL.B.*

On the non-Russian Populations of Russia in Europe. By R. G. LATHAM, *M.D., F.R.S.*

To the present communication one made in the Statistical Section is the complement. Therein are found the numbers, and distribution of the tribes under notice, as well as their names and classification. The general view of their history is all that is attempted here.

We clear the ground by laying out of our consideration the *recent* settlers or colonists, *e. g.* the *Greeks, Germans,* &c.; also the originally alien, though now naturalized, populations of the *Jews* and *Gipsies*; also the populations of the frontiers of the neighbouring kingdoms, &c.—*Wallachians, Bulgarians,* &c. Having done this, we find that the remaining populations are referable to three great families, viz.—

1. The *Turk,* by which is meant all those tribes whose language is akin to the Ottoman, or Osmanli, of Constantinople; its original geographical area being Independent Tartary.

2. The *Sarmatian,* by which is meant all those tribes whose language is akin to the Russian, Polish, Servian, Bohemian, Lithuanic, and Let. It falls into two branches, the *Slavonic* and the *Lithuanic.*

3. The *Ugrian,* by which is meant all those tribes whose language is akin to the Fin of Finland—*Fin, Lap, Tshud, Votiak, Tsherimiss, Morduin,* &c.

If we compare the tables laid before the Statistical Section with a map of Russia, we shall see the distribution of the different members of these different groups over the governments; and find,—

a. That the Ugrians lie north and west;

b. The Turks south and east; the

c. Sarmatians west—the *Slavonians* being south rather than north, the *Lithuanians* north rather than south.

The Ugrian populations, at present, are central, but in the southern parts discontinuous in their area, and separated from each other—fragmentary so to say. The hypothesis in respect to the original character of the Turk, Sarmatian, and Ugrian areas, and the history of the encroachments, conquests, migrations, and displacements by which it has since been modified, is that, with a Ugrian population in the centre, the Turks moved from south and east to north and west, and Sarmatians from west to east; the effect of these movements being to break up into fragments the Ugrian area, one which, upon evidence too lengthy for exhibition, can reasonably be extended as far west as the Dnieper, and as far south as the neighbourhood of the Black Sea.

On the Early Ethnology of Britain. By T. Wright, *M.A., F.S.A.*

On some Remains of an Early People in the South-eastern Corner of Yorkshire. By T. Wright, *M.A., F.S.A.*

STATISTICS.

On the Causes and Consequences of the Preston Strike, 1853 *to* 1854. *By* Henry Ashworth, *F.S.S., Vice-President of the Manchester Chamber of Commerce.*

The Preston strike of operative cotton-spinners and weavers began August 1853, and lasted till the beginning of May 1854, a period of thirty-eight weeks. It originated in a demand preferred by the work-people for an advance of 10 per cent. on the rates of wages then being paid in the town. It was alleged in support of this demand, that the rates of wages in Preston were generally lower than in other towns, and that the employers, when compelled to reduce the wages of their work-people in 1847, had given a promise to raise them on the arrival of better times. The masters, on the other hand, asserted that the rates of wages in Preston were, all things considered, equal to those paid in other towns; that no such promise had been given; and that a considerable advance had already taken place upon the wages paid in 1847. Notwithstanding these objections on the part of the masters, the demands of the work-people were generally conceded, only four firms actually refusing at the time the strike began.

In these circumstances, the immediate cause of the strike, or, as it soon became, the "lock-out," was the insubordination of the work-people. Encouraged by concession, they grew more exacting and imperious in their demands, till resistance became a necessity of self-defence. In several establishments the authority of the employer was at an end; he had no power either to dismiss or retain his servants; the dictation of the men in matters vitally affecting his interests, and pertaining exclusively to his own jurisdiction, was supreme. To meet these evils, the "Masters' Association," which had not been in active operation for several years, was revived, and a public notice was issued that the mills would be closed on a specified day, and remain closed till the work-people were prepared to resume employment in a more equitable and friendly spirit. In October, most of the hands belonging to the spinning and weaving establishments in the town, amounting to about 17,000, were out of employ; they were organized and drilled by leaders from other towns; a plan, extending throughout the whole of Lancashire, and embracing many of the principal towns in other parts of the kingdom, was systematized for obtaining pecuniary support; the grossest intimidation was practised towards all who refused to join them, and work-people from other places who came to seek employment in Preston, were induced by bribery or threats to leave the town. The masters subsequently offered to open their mills at the same rates of wages as were paid before the commencement of the strike. In January 1854, other manufacturers, in various parts of the country, came to the help of the Preston employers, and the "Masters' Defence Fund" was established. After various unsuccessful attempts at mediation, the strike came to an end in May 1854, the masters' terms being universally submitted to by the work-people.

The following statistics illustrate the leading questions involved in the contest.

First, to elucidate the general question of an employer's ability to raise the wages of his work-people, we give, in decimal proportions, the elements which enter into the production of a single piece of cotton goods of the current manufacture of Preston, and of the market value of eight shillings and fourpence, or 100 pence:—

The raw material, cotton, with the waste of manufacture	56	per cent.
The rent, or the use of mills and premises; the charges for wear and tear of steam-engines, mill-shafting, machinery, &c.; the expenditure in coals for fuel, flour for sizing yarn, oil, tallow, and other outgoings; travelling expenses, rates and taxes, together with the interest on capital and the manufacturer's profits on trade	19	„
The labour account, or wages of operatives	25	„
	100	„

This calculation shows that an advance of 10 per cent. on the wages of the operatives would increase the cost of the above piece of goods from 100 to 102½. In September 1853, the market price for the same fell from 100 to 95, adding 5 per cent. to the deficiency, and increasing the sum which the employer would have to make up in order to meet the demands of the operative to 7½, to be paid out of the 19 reserved for rent, &c.

In order still further to elucidate the ability or non-ability of the masters to give such an advance, we will suppose that a manufacturer employs 1000 work-people, and that their average earnings, children and adults together, amount to from 10*s.* to 15*s.* a-week. Ten per cent. on the larger sum would give an increase of 1*s.* 6*d.* a-week to each individual, or an aggregate of £3900 a-year. Towards meeting this we will suppose the manufacturer to retrench £1000 a-year in personal expenses, yet that which remains will make a difference of 2½ per cent. on the interest due upon a capital of £116,000; an advance of 10 per cent. on the wages of his work-people will therefore affect the payable investment of that large amount of capital.

The following figures will show the social importance of the Preston trade, which is chiefly carried on with China. The quantity of tea imported and left for consumption in this country was, in 1851, 53,965,000 lbs.; in 1852, 54,724,600 lbs.; in 1853, 58,860,000 lbs.;—average of the three years, 55,849,200 lbs.; or, the population of the United Kingdom being 27,478,181, two pounds of tea to each individual. The average cost of tea in China is 1*s.* per pound, and the prime cost of all the tea consumed in this country, £2,792,460. Towards this large sum we annually export grey and white shirtings to the value of £1,500,000, two-thirds of which, value £1,000,000, are supplied by Preston, which therefore supplies considerably more than a third of the population of the United Kingdom with tea. Further, a Preston manufacturer produces his 10,000 pieces of cloth a-week, and thus, reckoning each piece at 8*s.* 6*d.*, supplies cloth to the value of £221,000 a-year. The population of London, 2,362,236 persons, and their annual consumption of tea at two pounds per head, would be equal to £236,233. Thus a single Preston manufacturer virtually supplies nearly all the tea which is consumed in the metropolis of the British empire.

The following figures will test the probable utility to the work-people of the theory of partnership, as suggested by the Society of Arts. We will take as the basis of our investigations that part of the Preston trade which is carried on with

China, valued above at £1,000,000 annually. We have seen that 19 per cent. is the proportion of the value of a piece of cloth which has to bear a host of incidental expenses, and also supply the profits of the manufacturer. That proportion of £1,000,000 is £190,000. From this deduct, first, the interest due on the fixed capital employed in producing manufactures of that value. The capital sunk in the establishments of the associated masters of Preston is estimated at £1,000,000, four-fifths of which, or £800,000, may be set down as due to the China trade. Considering the uncertainty of trade operations, and the possibility of great occasional loss, 7½ per cent. is a rate of interest not more than equitable on that amount of capital. We have therefore to deduct £95,000 from £190,000, leaving an equal sum, from which we have to deduct all the other expenses mentioned above, for which, perhaps, 4 per cent. is a moderate allowance. From £95,000 we have therefore again to deduct £40,000, which leaves £55,000 as clear profit. Let this sum, instead of going wholly to capital, be divided between capital and labour, we shall thus have £27,500 to divide among the work-people,—probably 17,000 in number,—which gives them 7½*d.* per week, not much more than 5 per cent. on their present amount of wages. Thus partnership would destroy capital without enriching labour, and in time render labour worthless by exhausting the fund out of which alone it can be employed.

The pecuniary results of the strike are exhibited in the following calculations:—

Capital sunk in the establishments of the associated manufacturers of Preston		£1,000,000
Estimated trading loss to the employers	£50,000	
Loss by depreciation, interest and other contingencies, for thirty-six weeks	67,000	
Unavoidable expenses in wages, fuel and other items, during the strike	28,000	
Loss in working machinery without adequate number, and with inferior description of hands	20,000	
		165,000
Loss of wages to the operatives during the strike		250,000
Loss of the contributors to the strike fund, whose contributions became abortive by the failure of the strike:—		
Blackburn	£30,000	
Stockport	10,000	
Preston	7,000	
Ashton, Hyde, Glossop and Staleybridge	10,500	
Over Darwen	4,000	
All other places and trades	35,500	
		97,000
Estimated loss of profits to shopkeepers and innkeepers	£11,250	
Estimated loss to carriers, railway companies, dressers, sizers, mechanics, and other auxiliary occupations	10,000	
		21,250
Total loss to the community by the Preston strike		£533,250

On the Reformation of Offenders. By T. B. Lloyd Baker.

The author strongly recommended reformatories instead of prisons, and showed the salutary effects of a reformatory established in the county of Gloucester, near Cheltenham.

The Census of the Deaf and Dumb in 1851. *By* David Buxton, *Principal of the Liverpool School for the Deaf and Dumb*[*].

Enumerations of the deaf and dumb have been frequently made, in several European countries, and in the United States. The first time that any similar account was taken in this country was at the census of 1851. The general results are given

---

[*] This paper is published *in extenso* in the Journal of the Statistical Society of London, June 1855.

(1) in the Education Returns, and (2) in the Population Tables; but while the latter are on the whole very satisfactory, and likely to be exceedingly useful, the former are grossly inaccurate, and calculated to be as injurious as they are unjust. They do not correctly state either how much money is raised for the education of the deaf and dumb, or how many schools are supported, or how many pupils are instructed in them. Only a laborious comparison with the Population Tables will yield the information necessary for an accurate estimate. The Education Tables report nine institutions in England, and two in Scotland; but they omit altogether from the account, the Asylum in London, the Institutions of Birmingham and Exeter, a School at Rugby, the Institutions of Glasgow and Aberdeen, and the Deaf and Dumb department in Donaldson's Hospital, Edinburgh: yet from every one of these, returns must have been received; for all, without exception, are included in the Population Tables. Thus, it is discovered that there were not nine, but thirteen schools in England, which contained, not 392 pupils, but 816; and that Scotland had five institutions instead of two, which contained, not 89 inmates, but 250. The institutions in the United Kingdom contain at present 1401 pupils, and from their commencement they have educated about 6900. Tabular statements were read, showing the numbers of the deaf and dumb, and their proportion to the general population, in Great Britain and Ireland, the United States, France, and Prussia, and also in particular districts of these countries. The numbers actually under instruction in 1851, being compared with all who were of the eligible age, showed 34½ per cent. at school in Ireland, 50 per cent. in England and Wales, and 70 per cent in Scotland. Taking the whole deaf and dumb populations, Ireland educates 5 per cent., France 5½ per cent., England and Wales nearly 8 per cent., Scotland more than 11½ per cent., and the United States nearly 12 per cent. There are 200 Institutions in the world; a century ago there was not one. All the practical results accomplished are the work of the centennial period 1754 to 1854. In the former year the first Institution was founded; and it is the establishment of Institutions which has made the work of instruction permanent and progressive.

On the Supply of Gold from Australia and from English Rocks. *By* JOHN CALVERT.

On the Effect of Good and Bad Times on Committals to Prison. By the Rev. JOHN CLAY, *B.D., Chaplain to the County House of Correction, Preston.*

It has long been a popular opinion, that committals to prison increase in bad times. More than thirty years' observation of committals in North Lancashire lead to an opposite conclusion. In four ordinary years ending June 1824, the average annual committals were 119; in the prosperous 1825, the committals were 177; in the year of distress 1826, they were 172; and, in the year of reviving prosperity, 1827, they were 269. In 1836–37 a strike in Preston threw 9000 hands out of work, two-fifths of whom were under 19 years old. The consequent idleness caused an increase of young offenders; but the aggregate committals were less by 59 than those of 1827. In 1840 a county police was established. In 1842–43 great distress existed, attended by sedition and riot; yet in the year of *greatest* distress, the committals were 20 per cent. below those of the preceding year. The ten years ending June 1854, embraced two seasons of prosperity and one of extreme distress,—the distress unattended by any other influence which aggravates criminal tendencies. In 1847–48, 45,000 "hands" were out of work, or on short time: in the Preston Union, 12,000 adults were receiving out-door relief. Young offenders increased, but the aggregate of committals was 7 per cent. below that of the preceding year. Committals to the sessions during three hard years, 1846 to 1848, averaged 332 annually; during the four good years they averaged 390. Summary committals during the hard times averaged 718 yearly, during the good times 1249. In the last of these ten years, ending July 1854, the Preston strike threw 18,000 hands out of work. The committals to the sessions of males increased, of females decreased. Summary commitals of all classes decreased. Committals of all kinds in the six months of the strike, as compared with the six months preceding, decreased 32 per cent. Of 8500 young persons (under 21) out of employ, only 86 were committed to prison. During the strike, the lessened expenditure in public and beer-houses was a trifle more than £1000 per week.

The general conclusions from the above are, that hard times *may* add a few cases to the calendars, and that good times greatly tend to increase summary convictions. The increase to the sessions consists of the young, thrown into idleness; the increase of summary cases arises from the intemperance encouraged by high wages.

On the Fluctuations in the Herring Fisheries.
By JOHN CLEGHORN, *Wick.*

The author had his attention called to this subject by the notorious fact, that districts once prominent for their fishing stations are so no longer, and that fluctuations in the produce of this fishery form a striking feature in its history, and have never been satisfactorily accounted for. The assigned causes for the decay of fishing districts, and for the fluctuations in the produce of the fishery, he found were moral as well as physical, and the physical were generally as untenable as the moral, and the whole a jumble of contradiction.

To ascertain if there was a uniform law governing the whole, and what that law was, he tried to make himself acquainted with the natural history of the Herring. From the reports of the Board of Fisheries, and from other sources, he endeavoured to ascertain if there was anything like uniformity in the rise and fall of stations, and in the fluctuations to which the fisheries are subject. The result of his investigations are—

I. That the herring is not migratory, but a native of the waters in which it is found: that within very narrow limits races exist distinct in size, quality, and time of spawning, and always maintain their distinctive features: that in congregating for spawning the herring is brought within the scope of those agents employed for their capture, and those agents he found are, 10,974 boats, 41,045 seamen, employing 81,934,330 square yards of netting, an extent of netting that would cover an area of 26½ square miles, or, if extended lineally, would reach 4741 miles.

II. He found, that about twenty-five years ago the extent of netting was far less than that now used, and the produce of the fisheries nearly as great as at present, or that the increase of the herrings taken bears no proportion to the extended netting.

III. In the rise and fall of stations, he saw in the statistics a steady increase in their produce up to a culminating point, then violent fluctuations, and final extinction.

IV. He found that the races nearest the large seats of population, and in the most accessible waters, have first disappeared; and that in districts where the tides are rapid, as among islands, and in lochs, where the fishing-grounds are circumscribed, the fishings are precarious and short-lived; while on the other hand, extensive seaboards, having slack tides, with little accommodation for boats, were surer, and of longer continuance as fishing districts.

From these premises he concludes, that the extinction of districts as fishing-stations, and the fluctuations in the fisheries generally, are imputable to *over*-fishing, and that we are now doing for the east coast fisheries what has already been done for those on the west coast: that, therefore, the attention of the British Association, and through it the Government, should be called to the subject, that such arrangements may be adopted as will make the Herring Fisheries a perennial source of wealth to the nation.

On the Current Price and the Cost Price of Corn in England during the last Ten Years, as illustrating the Value of Agricultural Statistics. By JOHN TOWNE DANSON.

The purpose of this paper was to show the extent of the fluctuations of the *current* as compared with the *cost* price of corn, and particularly of wheat, and their disastrous effect on the capital employed in agriculture.

Using the Gazette returns of prices, and the Board of Trade returns of imported grain, Mr. Danson had formed a series of tables, showing the prices actually paid to the producer for the produce of each harvest since that of 1843, the apparent fluctuations of supply and demand, and the total sums paid (by the consumers) for British grain in each year. The most striking result obtained is apparent in the following figures:—

Total sums estimated to have been received by the British producers of wheat in each of the last eleven harvest years.

1843–44	£38,953,000	1849–50	£27,817,000
1844–45	43,910,000	1850–51	24,063,000
1845–46	41,672,000	1851–52	26,936,000
1846–47	50,989,000	1852–53	30,195,000
1847–48	37,647,000	1853–54	34,864,000
1848-49	30,009,000		

After tracing this fluctuation of the returns in the business of grain-growing in part to the absence of a mercantile spirit among the growers, and pointing out how, in other occupations, such obstacles as those of adverse seasons, and the irregularity of individual action, are frequently overcome, Mr. Danson suggested the use of a sound system of agricultural statistics as likely to be quite as useful to the farmer as to the consumers of his produce—saving the former from uncertainty in the investment of his capital as much as the latter from the distressing alternations of glut and scarcity.

On Decimal Coinage and Accounts, showing the impracticability of the franc or tenpenny unit. By JACOB A. FRANKLIN.

The author commenced by stating that the advocates of the penny integer delude themselves by assuming that the proposed "English franc" or tenpenny piece, would harmonize with the French franc, or that the proposed "English dollar," 5 francs or 50 pence, would harmonize with the U.S. dollar.

The following are the exact legal weights of fine bullion assigned by the respective Mints of England, France, and America, to the values named:—

	French 5 *fr.*	*American Dollar.*	*English* 50 *pence.*
	grs.	grs.	grs.
Gold ..	22·401795$\frac{15}{31}$	23·22	23·542001$\frac{131}{1869}$
Silver..	347·22783	345·5591	336·3636$\frac{4}{11}$

The disparities between these weights and values are such as to render it impracticable, even if it were honest, to palm off, internationally, the inferior coin for its nominal equivalent. Nevertheless, the closer the approximation—stopping short of complete equality—the less would be the protection of ordinary persons against fraud, error, and confusion incalculable.

It is obvious that the actual par of exchange (bullion against bullion) is, for gold, in inverse order to that of silver; and supposing it were honest and expedient to subvert our gold standard, even then, except a convention-money be concerted and rendered a legal tender in the several countries (like the *Conventions Müntze* of Germany), international exchanges would be more tedious to calculate between moneys differing merely 1 in a thousand, than between those differing 1 in 10.

All desire to stay by the simplicity of decimal accounts, and to abolish the complications of compound arithmetic; but it is found that we cannot preserve both the pound and the penny. For a host of cogent reasons we elect to retain the pound. The relation borne to the pound by the intervening shilling can be expressed decimally. Shall we discard both the pound and the shilling for the sake of the penny, which is not decimally expressible in either of the other denominations; and write henceforward 24 or 240 instead of 1 (pound)?

In the contest it is overlooked, that all existing *coins of circulation* might, as such, remain available, whether the pound or the penny be the unit of *account*. The copper penny might still pass 6 to the half-shilling, while the "Five,"—a small and obviously dissimilar piece of more valuable metal or alloy (perhaps silver, copper and nickel)—would circulate concurrently 5 to the half-shilling; and so enable the public ere long to choose between the two methods of harmonizing decimal accounts and decimal coinage.

On the Laws of the Currency, as exemplified in the Circulation of Country Bank Notes in England since the passing of the Act of 1844. *By* J. W. GILBART, *F.R.S.*

The author commences by observing, that it is a gratifying circumstance that questions relating to the currency are no longer connected with party politics, but are now regarded as presenting topics for scientific investigation, and he believed, that by no science can they be more clearly and successfully investigated than by the science of statistics.

The inquiries in this paper are limited to that portion of our currency which consists of notes issued by country bankers, and are considered chiefly in reference to those fluctuations in the amount of their circulation, which have occurred since the passing of the Act of 1844.

The Charter of the Bank of England was subject to renewal in the year 1844, and in that year was passed an Act of Parliament "to regulate the issue of bank notes, and for giving to the Governor and Company of the Bank of England certain privileges for a limited period."

The charges against the country circulation had been, that it was unsafe, excessive, and ill-regulated. The Act of 1844 dealt chiefly with the second of these accusations.

According to the provisions of this Act, no new bank of issue was permitted to be established in the United Kingdom, and the maximum amount of notes which each existing bank of issue might issue upon an average of four weeks, should, after the 10th October, 1844, be the average amount of the notes in circulation during the twelve weeks ending the 27th April, 1844; that returns should be made to government of the average amount of notes in circulation during each week, and if, upon an average of four weeks, the amount in circulation exceeded the authorized amount, the bank should be subject to a penalty equal to the amount of that excess; that if any existing bank not having more than six partners should increase the number of partners to more than six, it should lose the privilege of issue; that if any two banks should unite, so as to increase their number beyond six, they shall lose the right of issue; and if any banker shall become bankrupt, or cease to carry on the business of a banker, or cease to issue notes, it shall not be lawful for such banker at any time thereafter to issue any such notes.

The charge of being unsafe the Act did not meddle with, except so far as limiting the issues of each bank, and prohibiting any new bank of issue, may be regarded as elements of safety. But the Act of 1844 left the country circulation still unregulated by the amount of gold in the Bank of England. In the month of October, 1844, when the Act came into operation, the amount of gold in the Bank of England was £12,149,367. On the 23rd of October, 1847, the amount of gold was £6,745,354, but the law required no corresponding reduction in the amount of the country circulation. On the 10th of July, 1852, the gold had advanced to £21,845,390, but the law permitted the country circulation no corresponding expansion. It does not therefore appear to have been the object of the Act, that the country bankers should regulate their issues by the amount of gold in the Bank of England.

The provisions of the Act differ in some respects from those of 1845, passed in reference to the banks of Scotland and Ireland.

In England should any bank exceed its authorized issue, it would incur a penalty equal to the amount of the excess; but in Scotland and Ireland a bank may exceed its authorized issue, provided it has in its coffers an amount of gold equal to this excess.

There is still another difference in the laws of 1844 and 1845, with reference to England, and to Scotland and Ireland. In Ireland and Scotland two banks of issue may unite, and the united bank have the united circulation. In England, if two banks of issue, either of which has more than six partners, should unite, the circulation of one or both of these banks would be lost. Unions of banks in either Ireland or Scotland are not very likely, nor perhaps desirable. The banks are large, have a respectable capital, and enjoy the public confidence. In England many banks are small and have small capitals. Union among them would be highly beneficial. Yet such is the waywardness of legislation, that the Acts of 1844 and 1845 give facilities to unions in Ireland and Scotland, and restrict them in England.

There is another difference between England and Ireland. If any banks cease to issue, the Bank of England may extend her issue to two-thirds of the amount withdrawn. In a similar case, the Bank of Ireland may extend her issues to the whole amount thus withdrawn—Why this difference? we do not know.

The charter of the Bank of England will expire at the termination of twelve months' notice, which may be given by the Government, at any time after the 1st day of August next. It is not the object of this paper to examine any of the enactments of the Act of 1844 that have a reference to the Bank of England. But when the subject is brought under consideration, means should be employed to obtain some modification of those clauses that have a reference to the country banks. The country circulation should be preserved in its integrity—should be rendered capable of expansion, so as to meet the demands of a more numerous population, higher prices, and increased taxation,—its issue should be regulated by the demands of trade and agriculture in the respective districts in which the banks are established, and should be rendered as much as possible free from the operation of the foreign exchanges.

We find that in 1844, when the country circulation had greatly declined, we took the actual circulation of the then existing country notes, and made it a maximum circulation,—an arrangement which necessarily, from the fear of incurring penalties, reduced the amount of the actual circulation below the maximum. We apply this maximum to a circulation that fluctuated very much in different parts of the year. If, then, we keep below the maximum in April, we necessarily fall much lower in August. We divide this maximum among 277 banks, and impose heavy penalties upon every one that shall exceed his portion of the maximum,—a circumstance that tends to reduce still further the actual circulation. No one is forbidden to reduce his issue as low as he pleases; and if he abandons it altogether, only two-thirds can be supplied, and that by permission of the Government; and then only upon the application of a bank whose head-quarters are in London, who is to get nothing by the operation, and whose issues are governed by laws which have been declared by the country bankers to be inapplicable to the operations of a local currency, and unsuitable to the requirements of domestic industry. This maximum must never be exceeded, while those banks that previously issued Bank of England notes, are not allowed to resume their own circulation, and no new bank of issue is allowed to be established. The result of this arrangement has been, that an authorized issue in 1844 of £8,648,853, is now reduced to an authorized issue of £7,942,466, and that the actual circulation is generally below £7,000,000, and has been below £6,000,000; while every banker, in certain seasons of the year, has been compelled to watch the issue of his notes, lest he incur those enormous penalties which attend even the accidental violation of the Act.

In endeavouring to remove these inconveniences, we would be governed by a regard to the spirit of the Act of 1844, and attempt only to correct its practical evils. Among the modifications that may be suggested, perhaps the following may deserve a special consideration:—That the present maximum which applies to an average of four weeks should apply to an average of twelve months;—that all the banks who had formed agreements with the Bank of England, and whose compensation will cease in 1856, should then be allowed to circulate their own notes to the amount to which they had circulated Bank of England notes;—that the country circulation should not be less than the amount fixed by the Act of 1844, and that the deficiency of £706,387, which has since taken place, should be redistributed among the country banks (whether at present issuing or non-issuing), in the district in which the deficiency has taken place;—that we adopt the enactments of Scotland and Ireland, by allowing the existing banks of issue to extend their issues beyond their fixed amount, provided they have gold, either at the head office or at any of the branches, equal to the amount of the excess; and as Bank of England notes are a legal tender in England, and can be converted into gold upon demand, they might in this instance be placed upon an equality with gold;—that banks of issue, not having more than six partners, be permitted to continue their fixed issue in the same locality, even should they increase their partners to a greater number than six; and that this regulation be made retrospective, so as to include all unions of banks of issue with other banks that have taken place since the year 1844; and further, that we adopt the law of Scotland and Ireland by allowing two or more banks of issue, whatever may be the number of their partners, to unite and to retain the united amount of issue of all the united banks. With reference to the issue of notes under £5, we think that is a question for the consideration of statesmen, and its adoption must depend upon the political circumstances of the country. As long as Australia can supply us with gold sufficient to meet our foreign requirements and to maintain our domestic currency, probably we had better remain as we are. At the same time it may be useful to know, that, in case of necessity, we have here a magazine from which we may draw a large supply of the sinews of war.

On the Education of the Poor in Liverpool.
By the Rev. A. Hume, *D.C.L., LL.D., F.S.A.*

Suggestions for improving the present mode of keeping and stating the National Accounts. By Charles Jellicoe, *Fellow of the Statistical Society.*

The object of this paper was to show the many inconveniences arising from the mode in which the national accounts are at present stated, and to suggest a more accurate one, by means of which those inconveniences would be got rid of, and many real advantages obtained. It was pointed out, for instance, that *bonâ fide* purchases were on all occasions blended with ordinary expenditure, and thus not only were the annual expenses of the country improperly exaggerated, but the purchases themselves, from the nature of the arrangement, altogether lost sight of in a year or two, and thus any check upon a revenue arising from them also foregone. It was argued that if a proper statement were annually made of the national assets and liabilities, in which a due record was contained of all the items of the property belonging to the country as well as its "indebtedness," materials would be in a few years at hand which would afford at one view a complete insight into the financial condition of the country, and give the means of judging with comparative ease of the propriety and feasibility of such projects for its improvement as might at any time be brought forward. The returns from the Treasury, under Mr. Wilson's superintendence, were more carefully got up of late years than formerly, but they were without connexion or coherence. It was shown how this defect might be remedied, and how these returns might be condensed into the smallest compass without any sacrifice of the minutest details.

On the Rise, Progress, and Present Condition of Joint Stock Banks.
By James Knight.

The author commenced by glancing at the origin of the Bank of England, and its resources at different periods since the passing of the Bank Charter Act in 1844. The chief object was to exhibit the rise and progress of the several Joint Stock Banks carrying on business in the Metropolis, viz. the London and Westminster Bank (established in 1834); the London Joint Stock, in 1836; the Union Bank, in 1839; the Commercial Bank, in 1841; the London and County, in 1839; and the Royal British Bank, in 1849. The resources of these were, to the latest period of publication (June, 1854), in the aggregate 3726 proprietors, holding 186,084 shares, and representing capital "subscribed" £12,604,200, and "paid-up" £2,767,035. Deposits, £25,250,171, and the dividends ranged from 6 to 15 per cent., three of the banks paying 10 per cent., one 14 per cent. and one 15 per cent. At the three divisions of the quinquennial periods comparative analyses were made into the ratios of deposits to paid-up capital, profits to paid-up capital, and reserved funds to paid-up capital. At the end of the *second* five years the ratio of the reserved fund to paid-up capital was, in the case of the London and Westminster Bank, 8·353, and to deposits, 3·010; in the London Joint Stock, 20·019 and 4·91 per cent.; in the Union Bank, 11·823 and 1·763 per cent.; in the London and County, 13·208 and 1·948 per cent.; and in the Commercial Bank, 15·318 and 3·370 per cent. respectively. In the *third* quinquennial period these ratios were fully sustained. The dividends of the London Joint Stock Union and London and County Banks showed an *increase* of 2 per cent., 9 per cent., and 3 per cent. respectively.

By the returns published to the most recent date, viz. 30 June, 1854, the ratio of "deposits" to "paid-up capital" was 689·247 per cent. in the London and Westminster Bank; 972·984 per cent. in the London Joint Stock; 1662·681 per cent. in the Union Bank, and 421·969 per cent. in the Commercial Bank. The London and County Bank was, on 31st December, 1853, £866·995, and the Royal British, 1610·570 per cent. The reserved fund of the London and Westminster Bank was £125,307; of the London Joint Stock, £153,549; and of the Union Bank, £120,000. The latter increased from £50,000 to £120,000, by the appropriation of £70,000, derived from premiums on the issue of unallotted shares, at £5 premium. The prices of the shares were as follow:—

London and Westminster..	£20 paid..	Price £40..	£20 premium.
London Joint Stock	10 „ ..	„ 27..	17 „
Union Bank	10 „ ..	„ 28..	18 „
London and County	20 „ ..	„ 32..	12 „
Commercial	20 „ ..	„ 35..	15 „
Royal British............	5 „ ..	„ 5..	par.

An explanatory statement of the "Clearing system," and some remarks on "Limited and Unlimited Liability," concluded the paper.

On the non-Russian Populations of Russia in Europe. Communicated by R. G. LATHAM, *M.D., F.R.S.*

[From the Transactions of the Royal Geographical Society of St. Petersburg.]

The comment upon the following table (which gives the distribution of the various native and naturalized populations of European Russia over the different Governments) is to be found in the abstract for Section E., before which the geographical and ethnological view of the subject was laid.

Hence the two papers are complementary to each other, and may advantageously be read together.

I. UGRIANS.

Samoyeds.	
Of Archangel	4,495
Laps.	
Of Archangel	2,289
Voguls.	
Of Perm	872
Tshud.	
Of Novogorod	7,067
Olonets	8,550
	15,617
Vod.	
Of St. Petersburg	5,148
Esthonians.	
Of Vitebsk	9,936
Livonia	355,216
Pskov	8,000
St. Petersburg	7,736
Esthonia	252,608
	633,496
Lief.	
Of Kurland	2,052
Livonia (Liefland)	22
	2,074

Auramoiset.	
Of Novogorod	31
St. Petersburg	29,344
	29,375
Savakot.	
Of St. Petersburg	42,979
Izhor.	
Of St. Petersburg	17,800
Karelians.	
Of Archangel	11,228
Novogorod	27,076
Olonets	43,810
St. Petersburg	3,660
Tambov	?
Tver	84,638
Yaroslav	1,283
	171,695
Ziranians.	
Of Archangel	6,958
Vologda	64,007
	70,965
Permians.	
Of Viatka	4,599
Perm	47,605
	52,204

Votiaks.

Of Viatka	181,270
Kazan	5,500
Orenburg	?
Samar	?
	186,770

Besermanians.

Of Viatka	4,545

Tsheremis.

Of Viatka	75,450
Kazan	71,375
Kostroma	3,357
Nizhnigorod	4,330
Orenburg	2,626
Perm	7,938
	165,076

Mordvins.

Of Astrakhan	48
Kazan	14,867
Nizhnigorod	53,382
Orenburg	5,200
Penza	106,025
Samar	74,910
Saratov	78,010
Simbirsk	98,968
Taurus	340
Tambov	48,491
	480,241

Tshuvash.

Of Viatka	17
Kazan	300,091
Orenburg	8,352
Samar	29,926
Saratov	6,852
Shabirsk	84,714
	429,952

II. TURKS*.

Tartars (so called by the Russians).

Of Astrakhan	21,092
Vilna	1,874
Viatka	57,944
Grodno	849
Don Kosaks	629
Kazan	308,574
Kovno	415
Kostroma	262
Minsk	2,120
Nizhnigorod	22,788
Orenburg	230,080
Penza	34,684
Perm	17,271
Podolia	46
Riazan	4,725
Samar	83,927
Saratov	46,713
Of Simbirsk	67,730
Stauropol	96,037
Tauris	275,822
Tambov	10,640
Esthonia	12
	1,284,234

Karakalpaks.

Of Astrakhan	60
Orenberg	?
Perm	?
	60

Trukhmen (Turcomans).

Of Astrakhan	1,600
Stauropol	5,271
Tauris	450
	7,321

Khivans.

Of Astrakhan	190
Saratov	25
	215

Bashkirs.

Of Viatka	3,617
Orenburg	332,358
Perm	40,746
Samar	15,351
	392,072

Meshtsheriaks.

Of Orenburg	71,578
Penza	?
Perm	5,783
Saratov	2,580
	79,941

Kirgiz.

Of Astrakhan	82,000

III. SARMATIANS.

(LITHUANIC BRANCH.)

Lithuanians.

Of Vilna	138,320
Grodno	2,338
Kovno	568,794
Kurland	7,434
	716,886

Lets.

Of Vitebsk	142,497
Kovno	6,341
Kurland	401,939
Livonia	318,872
Pskov	458
St. Petersburg	2,000
	872,107

---

* This includes the Nogays.

SARMATIANS.

(SLAVONIC BRANCH.)

Bulgarians.

Of Bessarabia	64,736
Tauris	1,234
Kherson	11,132
	77,102

Servians.

Of Bessarabia	89
Ekaterinoslav	858
Kherson	436
	1,383

Poles.

Of Astrakhan	?
Bessarabia	733
Volhynia	150,000
Grodno	82,689
Ekaterinoslav	8,000
Kiev	100,000
Kovno	?
Kurland	12,888
Livonia	3,213
Minsk	?
Mohilev	?
Orenburg	?
Podolia	100,000
St. Petersburg	19,149
Saratov	?
Stauropol	?
Kherson	850
Esthonia	13
	477,535

IV. RUMANYOS.

(WALLACHIANS AND MOLDAVIANS.)

Of Bessarabia	406,182
Ekaterinoslav	9,858
Podolia	7,429
Kherson	75,000
	498,469

V. MONGOLS.

KALMUKS.

Of Astrakhan	87,656
Don Kosaks	20,591
Orenburg	?
Samar	?
Saratov	692
Stauropol	10,223
	119,162

VI. GREEKS.

Of Astrakhan	20
Bessarabia	3,353
Ekaterinoslav	32,633
Podolia	50
Tauris	5,426
Kherson	3,500
Tshernigov	1,791
	46,773

VII. ARMENIANS.

Of Astrakhan	5,272
Bessarabia	2,353
Ekaterinoslav	14,931
St. Petersburg	170
Stauropol	9,000
Tauris	3,960
Kherson	1,990
	37,676

VIII. GERMANS.

Germans Proper (*Deutsche*).

Spread over the whole empire, and to be found in different proportions in every one of the Governments. Total number	376,000

Swedes.

Of Kurland	7
Livonia	425
St. Petersburg	6,156
Kherson	168
Esthonia	4,714
	11,470

IX. DIOSCURIANS.

Georgians.

Of Astrakhan	290
Stauropol	710
	1,000

Irŏn (*Osĕt*).

Of Stauropol	1,650

Circassians.

Of Don Kosaks	130
Samar	?
Simbirsk	45?
	175?

X. PERSIANS.

Kuzzilbash.

Of Astrakhan	460
Samar	186
	646

Sarts (*Bokharians*).

Of Astrakhan	?
Orenburg	?

XI. INDIANS.

Of Astrakhan	10

XII. ALBANIANS.

(ARNAUT, SKIPITAR.)

Of Bessarabia	1,328

XIII. FRENCH.

Of Bessarabia	250

XIV. JEWS.

Talmudic.

Of Bessarabia	42,380
Vilna	69,397
Vitebsk	47,649
Volhynia	195,030
Viatka	58

Of Grodno	99,592
Ekaterinoslav	6,139
Kiev	103,326
Kovno	82,664
Kurland	23,486
Livonia	532
Minsk	88,880
Mohilev	83,715
Podolia	150,485
Poltava	16,140
Tauris	4,110
Kherson	22,424
Tshernigov	18,400
	1,054,407

Karait.

Of Vilna	424
Volhynia	320
Kovno	337
Tauris	4,198
Kherson	446
	5,725

XV. TSIGANI.

(GIPSIES.)

Spread over the whole empire, and to be found in different proportions in every one of the Governments. Total number 48,247

Statistics of Poor Relief and Movement of Population in the "Commercial District" in the Hundred of Wirral, Cheshire. By Mr. McNerney. *Communicated by* Sir J. P. Boileau, *Bart., F.R.S.*

The population of that portion of the Hundred of Wirral called the Commercial District, and to which the statistics refer, is 39,143 (1851); the nationalities, or the proportion of persons belonging to the respective countries, are is as follows:—

English	31,624
Irish	6,078
Scotch	1,441

The number of persons who became chargeable (*i.e.* received relief) during the years 1853–54:—

English 1090, or 1 in 29 in proportion to English population.
Irish 1441, or 1 in 4¼ in proportion to Irish population.
Scotch 38, or 1 in 38 in proportion to Scotch population.

Of the 1090 persons *English* who became chargeable, 281 had acquired a settlement; 213 had resided in the district 5 years without receiving relief; and 596 had not acquired a settlement, or resided 5 years without relief.

Of the 1441 persons *Irish* who became chargeable, 39 had acquired a settlement; 248 had resided 5 years without receiving relief; and 1154 had not gained a settlement, or resided 5 years without relief.

Of the 38 persons *Scotch* who became chargeable, 12 had acquired a settlement; 13 had resided 5 years without receiving relief; and 13 had not gained a settlement, or resided 5 years without relief.

The population of the district (Commercial) was, in 1841, 17,038; 1851, 39,143; and the estimated population for 1854, 45,774.

Area of the district in acres, 4862.

On the Treatment of abandoned Workings of the Australian Gold Fields. By H. E. Michel, *B.A.*

On Decimal Coinage.

By William Miller, *Cashier of the Bank of England.*

There was lately in the Money Article of the "Times" newspaper a criticism upon Mr. Laurie's pamphlet, in which the writer falls into the error common to all the advocates for keeping our accounts in pence instead of pounds, of supposing that the franc and tenpence are equal to each other. They begin by calling their tenpence a franc, and then reason as if it really were such.

A franc is about $9\frac{51667}{100000}$*d.*, or a remote fraction more than 9½*d*. Let that be clearly understood. In matters relating to money, the phrase "near enough for all practical purposes" will not do; the moneys of account must be identical for any statistical advantage to result. Two coins, as measures of value, to be equal to the same, must be equal to one another. A thousand tenpences are £41 13*s*. 4*d*. A thousand francs are £39 12*s*. 11½*d*. (or thereabouts), being a difference of about £2 in a value of £40. A thousand tenpences and a thousand francs are, therefore, not equal to the same, and therefore not equal to one another.

The writer referred to states, that "by preserving the penny from disturbance, the uses of all other coins would be retained." That is true; but what becomes of the decimal system?

Must I keep my accounts in pence, and decimals of a penny? or must I go down to pence decimally, and then begin to divide into farthings?

Must I keep my accounts in pence, and pay them in pounds?

Must I receive pounds, and record them in pence?

If they would retain the present coinage, all those questions must be answered in the affirmative.

Why do we want a decimal coinage? Because we want decimal accounts; and we wish to keep our coinage and our money of account identical as they are at present; and not to have a sum in "reduction" to do every time we pay and receive money.

If we are to have a totally new coinage, let it be stated broadly. Let us import the French franc at once, and then we shall not have a single coin the same. It is true, there might be some small confusion amongst ourselves, some slight difficulty in connecting the statistics of the past with the future; but we should be in harmony with France, and perhaps it is thought that that would fully compensate.

On the Decimalization of the Tariff. By WILLIAM MILLER. *Communicated by* ROBERT R. R. MOORE.

Magnitude and Fluctuation of the Circulation of Bills of Exchange, 1816 *to* 1853. *Statement of some of the results of a further extensive collection of Data. By* WILLIAM NEWMARCH, *F.S.S.*

Facts and Statements connected with the Question, Whether, in consequence of the Discoveries within the last Six Years, the Exchangeable Value of Gold in this Country has fallen below its former Level. By W. NEWMARCH.

After showing the immense increase in the metallic currency which the recent discoveries had caused, he gave it as his decided opinion that those discoveries had not had the effect of causing the exchangeable value of gold to fall below its former level, except indirectly; and that in this respect the commerce and general trade of the country had derived great benefits, and the social condition of the community had been materially improved.

On the different Plans which have been proposed of Decimal Accounts and Coinage. By THEODORE W. RATHBONE.

The great advantages of *this* system, of invariable progression by the number *ten* in all accounts, are so generally admitted and so easily established, that with little preface the inquiry may be entered upon as to the simplest, soundest, and best mode of proceeding of all the many that have been suggested and recommended upon high authority.

These are found to be *twelve* in number, besides several, brought forward in the disguise of new forms and names, whilst, in reality, identically the same as had been already proposed.

1st. Those introducing the widest range of figures in accounts, and being of necessity *only decimal in their steps* from the highest to the lowest of their four moneys of account, but in reality millesimal, and therefore *necessarily* requiring four columns of figures and moneys of account, in *all* accounts of even one pound in amount.

The scheme of this description proposed in the Report of the Committee of the House of Commons, dividing the pound sterling into *mils*, with intermediate decimal terms called *cents* and *florins*,—the scheme of Mr. Headlam and Mr. Davidson, dividing a new pound of 20*s*. 10*d*. into 1000 farthings, with intermediate decimal steps,—the scheme of "A Retired Merchant,"—of a Correspondent of the "Economist" and "Glasgow Citizen"—with various attempted modifications—are all shown to be alike bad and vicious in form, inconvenient, injurious and unjust, if not wholly impracticable in operation, most unnecessarily destructive of our present moneys of account and familiar coins,—in short, unsound in principle, and mischievous in result.

The suggestions for getting over these fatal objections are found to be alike ineffective and unjust, and such as neither have, nor are ever likely to have, the sanction of Parliament. Whatever variety of schemes, and under whatever new names and altered forms, and whether four, three, or two denominations are adopted, this *millesimal* division, by means of decimal steps of the highest money of account, *must* ever involve the same results.

2nd. The *second* class comprise the various schemes which surrender and abandon the pound as a money of account, and adopt a lower ruling integer or unit. These are the scheme proposed by Mr. W. T. Thomson, of the Standard Insurance Office, Edinburgh, to the Institute of Actuaries, adopting ten shillings as the highest money of account, and thus, by decimal steps, bringing out *halves* of the proposed moneys of the Committee,—a scheme shown to involve more than all the preceding objections, with only slight advantages gained in two minor points; the two schemes adopting 2*s*. and 1*s*. as the highest moneys of account—only in fact the plans of the Committee's Report and Mr. Thomson's, without their highest terms, the pound and the ten shillings, or ducat; and the three, now well-known, and most extensively and beneficially introduced, decimal systems of Europe and America—founded on *the dollar, equal to about five times* 10, *or* 50*d*. *English, the florin to twice tenpence* and *the franc to just about* 10*d*. *present English currency*. Notwithstanding that the first of these adopted *our own penny* as its foundation, and the consequent facility and simplicity of the transition from our pounds, shillings, and pence into the present American decimal currency, an examination of the principles and practical results of the French monetary system, with its smaller unit, shows *its* vast and instructive superiority to every other yet introduced,—but at the same time the utter impracticability and inexpediency of our adopting the proposition of Mr. James Yates, to introduce, intact and without modification, their beautiful "*système métrique*."

3rd. We are thus brought by a *process of exhaustion*, arising out of the unwarrantably injurious effects, and indeed impracticability of every other scheme whatever, to modes of proceeding little more than permissive, but affording, *almost without perceptible change or inconvenience of any description*, ALL we seek—a pure and perfect decimal system of accounts, entirely suited in results to every object, social and commercial, and at the same time leaving our present standard of value, as well as coinage, *wholly* undisturbed and unaltered in position. This system, fully explained in the author's work, entitled "An Examination of the Report and Evidence of the Committee of the House of Commons, with reference to a simpler, sounder, and more comprehensive mode of proceeding,"—absolutely requires nothing more than to substitute tenpence as the money of account instead of twelvepence—by rendering *the former* instead of *the latter* the *legal* form of account in this country. The important results of this were explained, and its further great *commercial* advantages (discovered and established by the late Mr. James Laurie), shortly given, in an account of his last valuable work, completed on his death-bed. Modifications of this last scheme were suggested by Dr. John Edward Gray, of the British Museum, and by Mr. Minasi.

Concluding observations were made on the other arrangements which might beneficially accompany this scheme on its introduction into this country, together with anticipations of the grand world-wide results to which it would ultimately lead.

The Statistics of Nice Maritime. *By* Col. Sykes, *F.R.S.*

The author gives a rapid analysis of the ancient and modern history of Nice,—of its physical and geological features,—of its botany, and zoology in their various branches; pointing out such products as are of œconomical application *. The meteorology from four daily observations is elaborately treated in considering its relation to local diseases and the public health; in consequence also of its having certain tropical features, which ten years' observations at Genoa give in a more marked form. In connexion with the meteorology, the official Hospital Returns of the Sardinian Government show that diseases of the respiratory organs at Nice, Genoa, and Turin, in frequency and fatality, equal those of Great Britain,—but that inflammatory action of the bowels is also a characteristic of the country. The author shows the mortality in the Civil, Military, and Foundling Hospitals.

The population of Nice is stated to have increased from 27,000 in 1823 to 33,811 in 1838, which rose to 36,804 in 1848. Old persons appear to have diminished in number, and young persons to have increased. From the local returns there would appear to be about one marriage to 123 souls, one birth to 28 souls, and one death to 29·3 souls in the town, and one death to 36·9 souls in the rural districts. The Sardinian statistical tables for ten years give one death to 24·97 souls, or 4 per cent. The annual increase of population by births over deaths may be roughly stated at 1 per cent. The author then gives an account of the government of the province and town through the agency of the intendente (Prefect) and the municipal elective council, who have promulgated seventy-four octavo pages of regulations for the ordering the police and the interior administration of the town, some of which might be adopted with advantage by the towns of states in a higher position than Piedmont. The author gives the budget of receipts and disbursements. In the latter are found grants in promotion of education and the fine arts, highly creditable to the municipality. The military defences, the medical establishments, the state of education in Sardinia, the learned professions at Nice, the newspaper press in Piedmont, and the ecclesiastical establishments are noticed in succession. With respect to the amount of instruction in the Sardinian states, the capacity to read varies from 6 per cent. at Nuovo in the Isle of Sardinia to 4 per cent. at Turin, and from 1 female in a hundred at Sassari in Sardinia to 22 in the hundred at Annency. The Sardinian states have four times the proportion of bishops to France, and seven times the proportion of Belgium; 14 times the proportion of Canons to France, and 19 times the proportion to Belgium.

Paganini's body is still unburied at Nice in consecrated ground, in consequence of not having taken the sacrament in dying. Nice sends two members to Parliament, and the representative system of Piedmont has that of Great Britain for its type.

The author gives a list of prices comparing 1841 with 1854, in which it is shown that prices have advanced. It is stated that 777 families of 14 nationalities wintered at Nice in the winter of 1852–53, and the paper concludes with an account of the money, weights and measures, which are of the French decimal systems, and the author argues, if this system could have been accepted by a comparatively ignorant and prejudiced people, there would be little difficulty in ensuring success in a similar attempt in England.

The Progress and Direction of British Exports, and the Influence thereon of Free Trade and Gold. *By* R. Valpy.

Referring to the several statistical abstracts recently published for the first time by the Government, the author sketches the increase of the exports of home produce from this country from 1840 to 1853, showing that their total value was £877,299,000; that they rose from £51,406,000 in 1840 to £98,933,000 in 1853, or nearly 93 per cent. Those to foreign countries rose from £34,431,000 to £57,950,000 in the same period; and those to British possessions abroad from £16,974,000 to £22,756,000. Further, in 1840, the proportion sent to European countries was 57 per cent., and in 1853 only 42 per cent. of the whole; while North America, which took 20 per cent. of the whole in 1840, took in 1853 no less than 33 per cent. To the United States alone our exports were, on an average of the years 1842–45, only £23,623,000; and in the years 1850–53 no less than £69,481,000. The general conclusions suggested by the author may be stated as follows:—That the average increase during the period has been larger to foreign countries than to British possessions. That our exports have averaged the proportions of about two-thirds to foreign countries, and one-third to the British possessions. That, with foreign countries in different parts of the world, the order of increase has been to North America, South America and Europe, and of Northern, Central and Southern Europe; the rate of increase being highest in the southern division. That with the British possessions the order of increase may be arranged to Australia, Cape of Good Hope, North American colonies, and the East Indies; and, finally, that to the United States and the other corn-growing countries, excepting only Russia, our exports have increased with our imports of corn. One fact noticed by the author seems extremely remarkable, namely, that for twenty years and upwards after the war which terminated in 1815, the declared value of our exports did not increase, but continued very much the same year after year, and those values were much less than they had been for fourteen years up to the termination of the war.

---

* It is stated that in the vegetable kingdom there are 124 families, 2231 species, and 151 varieties of plants; notices being given of the principal genera and species. 212 species of sea-fish, each with its patois name, are met with between Genoa and Nice, and freshwater fishes make up the number to nearly 280 species. Many of the molluscs are highly prized as food. Reptiles are few. The birds are numerous, amounting to 343 species, these having also patois names. The mammals are those common to Central Europe.

On a Method of substituting Francs and Centimes for the present English Metallic Currency, By JAMES YATES, *M.A., F.R.S.*

Assuming the superior excellence of the French monetary system, the author endeavoured to remove the objection which has been urged against this, and all other decimal methods on account of the supposed time required for effecting the change from the present English system,—an objection which has been supposed to be fatal to every improvement of the kind. He proposed that the transition should be carried out through the instrumentality of a paper currency, consisting of notes representing the value of a franc, and of all the higher coins; that persons should receive these notes in exchange for all the existing English coins, and that any minute difference arising from the impossibility of rendering every purchase of coin exact, even to the fraction of a centime, should be settled to the advantage of the person who offers the old coins, so that he would be certain to receive his due, or more than his due. The author thought, that the promissory notes, thus destined to call in the old coinage, might be issued in a month, and that to cash them would require a much longer time, but need not exceed twelve months at the utmost. As the process advanced, the lowest notes would shortly be superseded by the metallic currency.

Our silver coinage, as he observed, and offered to prove by weighing various specimens, is already, in regard to the quantity of silver which it contains, more fit to be used in the way which he recommended than in any other, probably a sixth part of the shillings now current being of the weight of not more than an equal number of francs. He proposed, therefore, that these, having been stamped to certify their recall, should be sent into circulation as francs; also, since a still larger proportion of the existing silver coins will soon be reduced by wearing to the weight of francs, and others will not repay the expense of recoining, he inferred that by far the greater part of the current silver coinage would be ready for immediate use on the proposed system.

He suggested that the whole of the copper coinage, consisting of tokens much below their assigned value, might continue to be used until it is worn out, the possible minute deficiency in value having been made good to the original owners through the intervention of the paper currency. The gold, he observed, ought to pass at its intrinsic value, which should be determined upon, as well as the value of silver, and made known by Act of Parliament and other methods.

The author recommended that no time should be lost in issuing an abundant supply of the two lowest coins in the proposed series, viz. centimes and two-centime pieces; and for centimes he proposed the form of the Chinese *cash*, for the sake of distinction and more general convenience in all small transactions. He showed the great advantages of such a speedy issue of centimes in teaching the use of a decimal system, as well as in introducing the coins of higher denominations.

Mr. Yates concluded in these words:—

"If such a plan as that which I have now endeavoured to delineate shall be adopted, nine-tenths of the quantity of pieces, and a far larger proportion of the amount of our present coinage, in both assigned and intrinsic value, will remain in circulation, and will be known to a great extent by the same denominations. Hence it appears probable, that the prices both of labour and of commodities will undergo far less derangement than might have been expected; for, although the same denominations will be applied to some silver coins of a little lower value, yet the depreciation occurring, at least in the most common cases, in equal proportion in regard to all objects and all transactions, it appears not unlikely that the disturbance attendant on the change may be almost imperceptible."

Mr. J. Yates's communication is published at full length in the Assurance Magazine and Journal of the Institute of Actuaries, No. XVIII. p. 146–151.

MECHANICS.

On Telegraphic Communication between England and America.
By FREDERICK BAKEWELL.

Mr. BAKEWELL proposed to effect such a communication by employing a single galvanized iron wire sufficiently strong to be self-protective, and to be insulated with gutta percha or other non-conducting substances, covered with tarred hempen yarn. Such a wire, it was stated, might from its comparative lightness and flexibility be readily stretched across the Atlantic, and at a cost of £100,000. A single wire would, in the first instance at least, be sufficient to supply the want of telegraphic communication, if the telegraph were kept in constant work. He alluded to the difficulty that had recently been discovered in transmitting telegraphic signals through an insulated wire immersed in water, and to the means that had almost as quickly been devised for overcoming the unforeseen obstacle. He expressed a confident expectation that should other difficulties arise in prosecuting such an enterprise, they would also be as readily vanquished.

On the Œconomical Working of Steam Boilers. By JOHN CHANTER.

The author explained the construction of his furnace with moveable reciprocating fire-bars for the prevention of "clinkers." As a proof of the advantage of the use of these fire-bars, it was stated that some of these furnaces which had been in constant work for two years remain in good condition, whilst ordinary furnace-bars last only six months. The depth of coal on the bars need not, it was said, be above half the usual depth in other furnaces; and there is consequently a saving of fuel. Tables in proof of this, and of other advantages, were appended.

On the large Fly-wheel lately erected at the Mersey Iron-Works, Liverpool.
By WILLIAM CLAY, *Liverpool.*

The object of this wheel is to regulate the speed of a large boiler-plate train of rolls without using any toothed wheel, as is generally done, which so often causes loss and annoyance by breaking.

In rolling boiler-plates, there is a certain limit to the speed at which the rolls should travel; in other words, the number of revolutions made by the rolls are very few as compared with the rolling of other descriptions of iron; and it was therefore necessary in a mill where direct action was required, that a fly-wheel should be constructed of sufficient size and weight to have, with a small number of revolutions, sufficient momentum to overcome the ordinary shocks of rolling large plates of iron. This could only be done by increasing the diameter of the wheel to such an extent that the rim should have the requisite momentum or velocity of so many feet per minute. With this view a wheel has been made of 35 feet diameter, and weighing about 60 tons, 24 tons of which is disposed in the rim, which is intended to run with a velocity of about 4500 feet per minute, at about thirty-eight revolutions.

Mr. **Clay** produced and explained the model of a machine used for rolling taper iron, by which an iron bar may be rolled of any length and tapered to any required degree. The principle of the action of the machine consists in allowing one of the rollers to rise in its bearings by hydraulic pressure. A valve, regulated by a fine screw, permits the water to escape, and thus, as the operation proceeds, the rollers become more and more separated, and the iron bar less flattened. By regulating the valve, so as to allow of greater or less escape of the water, the degree of tapering can be very accurately adjusted.

Mr. **Culley** explained the plans adopted for the transmission of time-signals through the electric telegraph wires in connexion with the Observatory at Greenwich.

On Ventilation of Ships. *By* J. CUNNINGHAM, *C.E., F.G.S.*

It is an acknowledged fact by all men practically conversant with the general condition of emigrant ships, as regards ventilation, that the means presently adopted to effect that important condition are very defective, if not altogether inadequate. In hot weather, in calms and stormy weather, on board emigrant ships, where so many human beings are usually crowded together, and in spaces proportionally less than are allowed for the commonest lodging-houses, the want of such means to effect a thorough ventilation is painfully and often fatally experienced by the poor emigrants. Many instances of those fatal effects might be given from the want of such means.

The means now employed for ventilating, not only emigrant ships, but even the best-appointed men-of-war or government ships, appear quite inadequate to effect that great desideratum, and it may be safely asserted, that without motive power a thorough system of ventilation cannot be carried out on board ships of any class.

By the application of this power a constant and most effective method of ventilation can at all times be carried on. In combination with it also is a simple process of disinfecting a ship, should an infectious distemper break out, in a most effective and rapid manner. The plan of the engine shown is calculated at three-horse power, and sufficient to ventilate thoroughly a ship of 1500 tons burthen, containing six hundred persons, and to afford to each person three cubic feet of pure air every minute. This supply is effected by two fans, as shown, performing 450 revolutions in a minute, thereby forcing the air down the main air-shaft to the side trunk flues, which extend along each side of the vessel. Small branch flues to the cabins and other parts of the ship requiring ventilation are joined into the main trunk flues. Each is provided with sliding or revolving ventilators to regulate the requisite amount of supply. The vessel at the top of the section is for disinfecting or for cooling the atmosphere. The tank at bottom is charged with water containing the disinfecting fluid, and the truncated cone, which we term a sprayor, is inverted with its smaller end into the fluid; its upper end spreads out as shown, and is perforated. This vessel rotates rapidly, and the fluid by the centrifugal force is drawn up and thrown out in spray, through which the air must pass into the fanners, thus becoming impregnated in its passage with the disinfecting material, such as the chloride of zinc or of lime. In like manner the air could be readily and rapidly cooled to a low degree of temperature by placing in the tank a moderate quantity of ice. This may be applied in the tropics or when required.

The cost of providing a steam-engine, boiler and apparatus complete, including flues, &c., for a ship of 1500 tons burthen, similar to the plans now exhibited, we estimate at between £450 to £500. The quantity of fuel required to keep the engine at work night and day for a hundred days would be about 20 tons.

In addition to the process of ventilation, we propose also to adapt the engine to several other purposes, such as the loading and discharging of the vessel, lifting the anchors, pumping the ship and supplying water to the water-closets, and for cleaning the decks. Further, it is proposed to apply the waste steam to the purposes of cooking.

On the Œconomical Working of Steam Boilers and Furnaces, by the saving of Fuel, with a more speedy command of Steam. By W. DAY, *London.*

The first patent of this description of furnace had all moving bars, put in motion by several cranks, levers, &c., and though found to be a great improvement upon stationary bars, were liable to derangement in the hands of careless stokers. The further improvements consist in the simple use of toothed or serrated bars, with rockers, supported by brackets in tubular, and by boxes under round, waggon, or other shaped boilers, pans, &c. On the rockers, moving serrated bars are placed, so as to work alternately between fixed serrated bars. By use of a hand-lever, the stoker easily effects a movement of the reciprocating bars, and at once cleans the entire surface of the fire-grate from dust and small cinders, thereby preventing the formation of clinkers to a great extent, and the burning away of the bars, while fresh air passes more freely between the bars, causing a more perfect and brisk combustion of the fuel, and consequently rendering it possible to have a better fire with a less depth of fuel, and to generate steam more quickly.

On the Prevention of Boiler Explosions. By H. DIRCKS.

The plan Mr. Dircks proposed is to have a pipe leading from a cistern of cold water pass through the boiler, whilst the stopcock that opens the passage is to be kept closed by a chain within the boiler, and in which chain one link is made of fusible metal.

On a New Washing Machine. By J. ELDRIDGE.

On the Consumption of Fuel and the Prevention of Smoke.
By W. FAIRBAIRN, *C.E., F.R.S.*

Mr. Fairbairn explained the principles on which the perfect combustion of fuel depends, and expressed his opinion that by proper attention and by the adoption of the means already known and practised, the issuing of smoke from steam-boiler furnaces might be effectually prevented. The great secret is to have sufficient capacity in the boiler; and if the boilers had double their usual capacity, the perfect combustion of the fuel, and, consequently, the prevention of smoke, might be readily accomplished. He referred to the steam-engine furnaces of the Cornish mines to prove that when there is a sufficient inducement to the proprietors by the saving of expense, and of incitement to the engineers by competition, the emission of smoke is prevented without any special arrangement to produce that effect. Mr. Fairbairn then described a furnace which he conceived offered great facilities for the more perfect combustion of fuel. It consists of two furnaces united into one, the gases issuing from the coals being mixed together in a single chamber and then passed in a heated state over the bridge of the furnace, where they are ignited. By this means, and by keeping the fire-bars clean for the admission of air, the combustion was rendered very complete.

On the Solidification of Bodies under great Pressure.
By W. FAIRBAIRN, *C.E., F.R.S.*

This paper contained the results of a portion of the experiments conducted by himself, Mr. Hopkins and Mr. Joule, at the request of the Association, and by means of funds supplied for that purpose by the Royal Society. At the last meeting at Hull, Mr. Hopkins alluded to these experiments, and then explained the nature of the apparatus invented by Mr. Fairbairn for submitting the substances to be operated on to the enormous pressure of 90,000 lbs. on the square inch. In these inquiries the objects kept in view were, to ascertain the exact laws which govern the cohesive strength of bodies in their present physical condition, and how far a knowledge of those laws may conduce to the reduction of the metals and their subsequent solidification under circumstances whereby increased strength and density may be obtained. The experiments commenced with spermaceti, bars of which were cast and left to solidify at the same temperature, but under different pressures. When pressure was applied to these bars, the one that sustained a pressure of 40,793 lbs. carried 7·52 lbs. per square inch more weight than one submitted to a pressure of 6421 lbs., the ratio being in favour of the more strongly compressed bar, in its power of resistance to a tensile strain, as 1 to ·876. It appeared from these experiments, that bodies when solidified under pressure have not only their densities greatly increased, but their molecular structure is also materially affected, so as to increase their adhesive power. Still further to elucidate the subject, cubes of exactly one inch were carefully prepared and loaded with weights till they were crushed. The first cube, solidified under a pressure of 6421 lbs., was crushed with 213 lbs. Tin was then operated on, a quantity of pure tin being melted and then allowed to solidify; first at the pressure of the atmosphere, and afterwards at a pressure of 908 lbs. on the square inch. The same quantity taken from the same ingot was subsequently submitted to a pressure of 5698 lbs. on the same inch. The bars, after being solidified and allowed to cool for upwards of fourteen hours, were subjected to the usual tests of tensile strains. From these experiments there was derived, as nearly as possible, the same law or measure of strength in regard to the effects of pressure as obtained from the experiments on spermaceti; for with the same pressures of 908 lbs. and 5698 lbs. upon the square inch, the breaking weights were 4053 lbs. and 5737 lbs. or in the ratio of 1 to ·706, being an increase of nearly one-third on the crystallized metal when solidified under about six times the pressure. From these facts Mr. Fairbairn observed, it is evident that the power of bodies to resist strain is greatly increased when solidified under pressure; and he said he considered it highly probable that the time is not far distant when the resisting powers of metals, as well as their densities, may be increased to such an extent as to ensure not only greater security, but greater œconomy by solidification under pressure. He said he was borne out in these views by the fact, that the specific gravities of the bodies experimented on were increased in a given ratio to the pressure. Spermaceti solidified under a pressure of 908 lbs. on the square inch had a specific gravity of 0·94859; whilst that solidified under a pressure of 5698 lbs. had its specific gravity increased to 0·95495. The specific gravity of tin, solidified under a pressure of 908 lbs., was 7·3063; and that solidified under a pressure of 5698 lbs. was 7·3154, which gave ·0091 as the increased density from pressure. There are further experiments in progress to determine the law that governs this increase of specific gravity, and to determine the conducting powers of bodies solidified under severe pressure. Experiments have also been made on such substances as clay, charcoal, and different kinds of timber. From the experiments on powdered dry clay, it appeared that a bar of that substance 3½ inches long and 1½ inch diameter, after being hammered into the cylinder, so as to become slightly consolidated, was reduced in bulk with a pressure of 9940 lbs. on the square inch to 2·958; with a pressure of 54,580 lbs. to 2·3; with 76,084 lbs. to 2·288; and with a pressure of 97,588 lbs. to 2·195 inches.

Mr. GIBSON exhibited the model of a machine intended to prevent accidents in mines. This contrivance consists in having a spiral inclined plane passing round the outside of the perpendicular shaft of a mine, by which plane the miners might ascend and descend without the necessity of being lowered in baskets down the shaft.

On Cunningham's *Plan for Reefing Topsails.* *By* J. GRANTHAM, *C.E.*

This plan consists of an arrangement by which the yard-arm is made to turn round as it is lowered by a pulley fixed to the mast, and the slit in the centre of the sail through which the rope passes, to effect that movement of the yard-arm, is closed by a sail-cloth valve that preserves the action of the sail intact.

On Fisher's *Venetian Screw Propeller.* *By* J. GRANTHAM, *C.E.*

The object of this propeller is to prevent the retardation which occurs in an ordinary screw propeller, by the tendency to produce a vacuum at the back of the blades of the propeller. To effect this, Mr. Fisher makes slits in the blades to allow the water to pass through, and thus to supply the place of the fluid which is drawn backward as the screw turns round. These slits give the propeller somewhat the appearance of a Venetian blind, and hence its name. Mr. Grantham said the propeller had been tried in the Birkenhead Docks with good effect.

Mr. JOHN GRANTHAM described his plan for a high-level railway for the Liverpool Docks. A model on an extensive scale of the proposed railway was placed in the Great Hall, and was one of the objects of attraction during the meeting of the Association. The railway is proposed to be placed on the east side of the whole line of docks. It is to consist of iron framework, supporting two platforms,—the lower, with four lines of rails, to be about 52 feet wide and 20 feet above the present quays, entirely for goods; and an upper platform, with two lines of rails, exclusively for passengers. As the present length of the Liverpool Docks is four miles, and will in a short time be extended to five miles, the necessity of some improved means of conveyance along the docks is becoming more and more urgent, and the facilities which such a railway would present for the shipment of goods without the risk of injury to which they are now exposed was strongly enforced by Mr. Grantham. It is intended that the railway should be ultimately placed in connexion with the other railways into Liverpool, so that goods may be conveyed direct to the docks without being reloaded. The cost of such a railway is estimated at £250,000 a mile, and the revenue from passenger traffic alone, it is calculated, would be amply remunerative, whilst the quay space gained by the platforms of the railway would be nearly equal in value to the whole outlay.

A mechanically adjusted compass, supported by vulcanized india-rubber springs, was exhibited by Mr. GRAY; the object of which was to prevent the action of the needle being influenced by the motion of the ship.

On the Strength of Iron after repeated Meltings. *By* WILLIAM HAWKES.
[*In a letter to the Assistant General Secretary.*]

East Foundry, Birmingham,
Sept. 23, 1854.

DEAR SIR,

I enclose you an account of some experiments that I have had made upon the strength of iron as derived from repeated meltings. I did not commence upon these experiments till after the Hull Report of the 23rd Meeting was in my hands, which has not left me time enough to complete the experiments upon the Hot-blast Mine No. 1, Corbyns Hall iron.

The iron was melted in an ordinary pot furnace, the pot holding about 70 lbs. weight. I have given only the strength of the stronger of the two bars which I had cast, and therefore in making the comparison with Mr. Fairbairn's experiments I have taken only the strongest of the three bars. I have in each case tested the strength of the iron in the Pig by having it filed down to 1 inch square, which was not done with the Eglinton iron.

The Corbyns Hall, near Dudley, No. 1 (pig), was more of the No. 2 quality, but good melting iron. It was not until the thirteenth melting that the outside of the fracture became white, the interior being light grey, and in the fourteenth melting this light part had increased, leaving a grey core of about three-quarters of an inch in diameter in the middle. Indeed it assumed very much the appearance of the bar of the fifteenth melting of the Eglinton iron, exhibited at Hull last year. The Corbyns Hall iron was quite fluid at the twenty-ninth melting.

3 ft. Bar, 1 in. sq. Blaenavon Iron. Strong bright forge. Pig before melting, 845.			3 ft. Bar, 1 in. sq. Corbyns Hall, near Dudley. Hot-blast Mine No. 1. Pig before melting, 693.	Mr. Fairbairn's Experiments on No. 3 Hot-blast Eglinton, the bars being 4 ft. 6 in.
Melting 1	White with brown core	794	749	714
„ 2		794	704	677
„ 3	Fracture white ...	866	941	556
„ 4		811	921	621
„ 5		854	974	621
„ 6		1026	834	649
„ 7		946	889	789
„ 8	Faulty bar ..		994	696
„ 9	Do. do...		929	770
„ 10	Bar faulty...		969	854
„ 11		864	1051	920
„ 12		721	1166	1060
„ 13		851	841	920
„ 14		740	Fracture light grey, with white ring outside 801	864 565
„ 15	Faulty bar ..		904	490
„ 16		877	978	472
„ 17		926	1105	
„ 18		1014	1120	
„ 19		1048	1089	
„ 20		839	805	
„ 21		929	796	
„ 22		810	829	
„ 23	Pot broke.		966	

Corbyns Hall (*continued*).	
Melting 24	1116
„ 25	853
„ 26	926
„ 27	929
„ 28	956
„ 29	928

Blaenavon strong bright forge fracture of pig of the ordinary light grey crystalline structure of hard forge pigs.—At the first melting it became white, with a brownish greyish core in the middle, of about ¼ in. diameter. The fractures of all the other meltings were white, but for the three or four last meltings the iron became softer, and would file; it had also lost its silvery whiteness and became of a more dead colour.

I see by a memorandum I have found, that I tested this iron in 1821, when the strength was 1090 lbs. for a 3-ft. bar.

It is only in the third melting that the original strength of this pig iron, 845 lbs., is obtained, viz. 866 lbs., while in the No. 1 Hot-blast Mine pig, the strength of which was only 693 lbs., it increases to 749 lbs. in the first melting. You will note, that I arrive at the same maximum strength in the twelfth melting of the No. 1 iron that Mr. Fairbairn did; the Corbyns Hall rising from 749 lbs. to 1166 lbs., and the Eglinton from 714 lbs. to 1060 lbs. in the twelfth meltings. The maximum strength of the Blaenavon is at the nineteenth melting.

At the twenty-third melting the pot broke, and much of the iron ran into the ash-pit, but that which remained in the pot ran out quite fluid, but set immediately. About 22 lbs. weight of coke was used to each melting, taking about one hour. The weight put on the bars at each time was 2½ lbs. I have added the weight of the bars and ⅔rds the weight of the pigs, in all the weights given, which was the total breaking weight.

W. Hawkes.

On Ocean Steamers and Clipper Ships.

By Andrew Henderson, *A.I.C.E.*

Speed, size, and proportions.—Considering actual experience at sea the only guide in the application of science to the improvement of our shipping, the author has for some years laboured to obtain a record (in the archives of the Institute of Civil Engineers) of the size, proportions, and form of steam-vessels, as well as the speed actually realized on the several seas traversed by our steamers. An abstract of the result was exhibited in a tabular form, showing the comparative tonnage, bulk, dimensions, displacement and resistance, and other particulars, of vessels built or designed for the various services and seas to which navigation is extending.

By reference to these results, and the diagram of the midship section, an approximate estimate may be made of their relative form, resistance, bulk, or capability for navigating the ocean. In the upper lines of the table were found the tonnage, dimensions and proportions of most of the earliest ocean steamers constructed by eminent builders, with the actual speed realized by them on mail service, some extending over six years, and all over many thousand miles. This information, from official returns between 1845 and 1851, shows that on an aggregate of 1,271,000 miles the realized speed only averaged 7·945 knots per hour in the Mediterranean and Indian Seas. The general average of the earliest steamers on the West Indian line was even below this, while the earlier vessels placed on Mr. Cunard's line realized 9 knots.

As to the relative speed of different vessels, it was seen in the last column that the length of the five steamers that realized 8·50 knots per hour averaged less than six times their breadth, whilst those that realized less than 7·50 knots averaged upwards of seven times their breadth. The form being as important to speed as the proportion, the midship sections of several of these were given in the diagrams. Three on the right-hand side,—the 'Great Western,' 'Precursor,' and 'India,'—may be considered the type of the original large ocean steamers built on the Avon and Clyde; the 'Thames,' 'Oriental,' and 'Hindostan' representing those built on the Thames and Mersey. In the absence of actual sections, the form of the latter, and other vessels, may be approximated to by reference to the columns of the table, by which it will be seen that these timber steamers have all extremely flat floors and straight sides, and are of considerable depth. The diagrams as well as the tables show the ratio of breadth to depth and length, and the ratio of displacement to area of section, loaded to one-third and two-thirds the height of deck, affording a fair criterion of the burthen and resistance of different vessels.

The sections of the 'Great Western,' built by Mr. Patterson in 1838, the 'Precursor,' by Mr. Napier in 1841, and the 'Comprehensive,' designed by the author in 1839, show a great similarity in form and rise of floor, their proportion of length being 5·86, 6·08, and 5·71 breadths respectively; the relative tonnage of these three steamers being 1242, 1476, and 2015 tons by the old law, as deduced from their length and breadth, without reference to the depth, thereby affording no criterion of their relative bulk or displacement.

The 'Oronoco' represents a class of very large paddle steamers, built of oak timber and long planking, with great steam power, for the West India mail service, of ten knots. The 'Solent,' for the same service, is built of three thicknesses of plank, with a view to lightness and speed. It is well known that some of these very long vessels have proved deficient in strength, and that their consumption of coal is enormous.

The 'Asia' and 'Arabia' represent the improved North American mail steamers of Cunard's line; they are built of timber, and their average speed in fifty-four voyages in 1852 averaged rather more than 10¼ knots an hour. The ratio of length to breadth of the 'Arabia' and other timber vessels is about 7·00 breadths, but they have considerably more rise of floor and finer lines than the earlier vessels, their size being about 2400 tons, old or builder's measurement.

The American steamer 'Arctic' represents the class of vessels known as Collins's line, between New York and Liverpool; they are said to have averaged eleven knots, and are all built of timber of very heavy scantling. Their tonnage is greater than that of the Cunard line, having greater breadth, their ratio of length being 6·27 as compared with 7·00 of the Cunard line. The 'Susquehanna,' 'Golden Age,' and 'Georgia,' three other large American steamers, have a proportion of 5·71, 6·53 by 5·20 breadths; the latter, the broadest, being spoken of as an excellent sea-boat.

Of screw-steamers, the peculiar form of the 'Great Britain' shows a very flat floor for half the breadth, with a rise from floor to main breadth, and rounded home side with a light draught of water; the tonnage is about 3400 tons, and her ratio of length to breadth is 5·78. The largest and longest vessel yet constructed is the

'Himalaya,' built on the Thames by Mr. Mare, for the Peninsular and Oriental Company, measuring 3528 tons, and having a ratio of length to breadth of 7·41; her length is 341 feet, and her breadth 46 feet. Although of great length, the water lines at bow and stern are so sharp and fine, that the buoyancy or resistance to the sea is thrown nearer the centre than in shorter or fuller ships.

It will be seen by the midship section that her rise of floor is very great, with a straight side of moderate depth; and she has realized the highest speed between England and the Mediterranean. The 'Bengal,' 'Argo,' and 'Victoria,' are three large screw steamers, of recent construction; they measure respectively 2180, 1840, and 1834 tons; their ratio of length to breadth is 7·61, 6·20, and 6·85, and were built by Messrs. Tod and M'Gregor, Messrs. Mare, and Messrs. Scott Russell and Co. respectively.

A return of the services and voyages of vessels will give the only true account of speed realized; but if accompanied by the dimensions, proportions, displacements, &c., in the tabular form, and diagram of midship section, much valuable information will be diffused, bearing on the more important questions of relative strength and seaworthiness.

The term "clipper ship" is applicable to all vessels in which speed is made the primary object. Acting on this principle, in 1831 Mr. Henderson built the clipper 'Waterwitch' (a model was placed on the table) so sharp and shallow, as to stow a cargo of only one-half the 380 tons registered; while carrying the sails of a 500 ton ship, having a numerous crew to man her efficiently, experience proved her very long masts and square yards were within the limits of safety. The ship being still employed in the China trade, though twice twelve years old, is evidence of her being safely built, rigged, and well-proportioned as a sailing clipper, her length being 3·75 times her breadth. In 1842 he built the 'Kelpie,' of the same tonnage register, but increased the length to four breadths, with less rise of floor, as shown in model and diagram of midship section.

There being some thirty English clippers between India and China, several American clippers were built to compete with them, of much larger tonnage and greater length. Their success induced the extension of the clipper principle into the China, the California, and the Australian trade, for which the iron shipbuilders of England and the timber shipbuilders of America are alike competitors.

The Americans have very large ships: the 'Great Republic' may be cited as an instance: her tonnage was 4535 tons, length 325 feet, and her breadth 53 feet; her ratio to length 6·13 breadths. She was unfortunately burnt when ready for sea, so that no practical experience has resulted from this enterprise. The sides of the 'Great Republic' are three times as thick as those of the 'Bengal,' an iron steamer of great length. It would be useful to record the proportions, form, &c. of the 'Tayleur,' as showing the extreme length to which sailing ships are now being built. In this ship the designed 204 feet was lengthened by the owner to 225 feet, and the proportion of 5·77 breadths.

Very large vessels—their seaworthiness.—The Report of the Directors of the Eastern Steam Navigation Company states the dimensions and power of their intended ship to be as follows:—length, 680 feet; breadth, 83 feet; depth, 58 feet, with screw and paddles; the engines of a nominal horse-power of 2600 horses. Calculated by the old law, the tonnage of this vessel would be 22,942 tons, being twice the length of the 'Himalaya,' and nearly a furlong or cable in length.

Holy Writ records that Noah's Ark, launched on the waters of the flood 2340 years before Christ, was 300 cubits long, 50 cubits broad, and 30 cubits deep, the proportional length being six times the breadth, and the depth 6-10ths of the breadth. By old law, the tonnage of Noah's Ark was 11,905 tons, and calculated on this estimate, her external bulk would be about 1,580,277 cubic feet; the ship built 2000 years ago at Alexandria, by Ptolemæus Philopater, 6445 tons; while that of the modern Ark, designed by Mr. Brunel, and building by Mr. Scott Russell, would be 22,942 tons, and 2,973,593 cubic feet bulk, and her length is 8·19, or eight and one-fifth times her breadth.

The speed, œconomy and comfort promised in this vessel building on the Thames, attract for it a large share of public attention, but little consideration has been given to the subject of *its security in heavy* SEAS, its capabilities for navigation, and the effect of an ocean wave on a vessel of such extraordinary length. It is true that such a vessel may often cross the Atlantic without encountering such a sea as would endanger her, but Mr. Henderson affirms that he has seen waves of a height of 50 feet, from crest to hollow, and argues that it is impossible for a vessel of this length and proportion to be kept under command in such a sea should any accident happen to her machinery.

The investigations of Dr. Scoresby show that the elevation of the Atlantic waves in a hard gale was as much as 43 feet. Others estimate the mean elevation at 20 feet, with a length of 160 feet, and a velocity of 30 miles per hour. We may therefore estimate the usual gales in the Atlantic as producing a wave 25 feet in height and 200 feet long. The author doubts the capacity of such a ship under such pressures, and cites examples of this in three American steamers, the 'Frome,' the 'Vanderbilt,' and the 'San Francisco.' The former was lost; the Vanderbilt fell into the trough of the sea, and was struck by a wave which carried away all her bulwarks, made a clean sweep of her deck-houses, and put out all her fires. The San Francisco, a large steamer, bound to California, caught in a north-west gale in the Gulf-stream, being disabled got into the trough of the sea; she became perfectly unmanageable, and part of the crew and 150 passengers were washed off her, the decks actually being stove in, they having no command over her when under sail alone. This difficulty may be obviated by the ship being provided with a rudder at the stem as well as the stern, and by having before the after rudder, and above the screw shaft, a steering paddle or three-armed paddle across the stern, the wheel being two-thirds its diameter above water, to be worked by a ten-horse engine.

Descriptive Measurement for Tonnage.

By an Act passed in 1836, and amended in 1845, a rule was adopted, based on the internal measurement of eleven breadths and four depths, taken at three sections, the divisor 3500 leaving the registered tonnage.

In 1849, the Tonnage Committee, including Mr. Parsons and Mr. Moorsom, shipowners, naval and mercantile captains, reported "that the equitable basis charges for dock, light, harbour, and other dues, was that of the entire cubical contents measured externally to the height of the upper deck by the use of diagrams of sections and curves of the areas."

Mr. Moorsom proposed a mode of computing the internal capacity without the aid of diagrams or curves of areas, and of ascertaining the tonnage by dividing by 100 as more convenient. In May 1850, the author transmitted to the Board of Trade a revised plan, showing that the mode of external measurement and computing the bulk adopted in the bill of 1850, is equally applicable to ascertaining the internal capacity; and that by one measurement, taken either externally as in bill, or internally as proposed by Mr. Moorsom, both the external bulk and internal space could be ascertained by means of transverse sections and curves of areas.

To meet the inequalities of light goods and dead-weight cargoes, and those of timber-built ships and iron vessels, it was then proposed, and still advocated, to combine the advantages of external measurement, recommended by the Tonnage Committee of 1850, with the internal measurement proposed by Mr. Moorsom and adopted in April 1854, in the bill to come into operation in 1855, by taking the mean of the external bulk and the internal space in cubic feet, thus forming an average between timber ships and iron ships, light cargo and dead weight, as the basis of register tonnage. The Tonnage Committee in 1849 ascertained, by measuring the external bulk, or cubic contents of many vessels, that the ratio of old, or builder's, tonnage to the bulk or displacement to upper deck was 27-100ths. The factor ·27 was adopted in the bill of 1850.

The bill of 1854 adopts 100 as the divisor of the internal capacity for the register tonnage based on the internal space only, instead of which it is proposed that the rules for external measurement should be added to the 20th clause of the Merchant Shipping Bill before it comes into operation in May 1855. A factor of 30, 31, or 32-100ths of the mean bulk and space could be fixed for each 500 tons, so that it should produce a register tonnage a little below the old law or builder's measurement, and thus approximate the rule or tonnage used by foreigners.

The practicability of computing both bulk and space from one measurement, taken either externally or internally, is exemplified by the diagram of midship section of a steamer of 350 tons O.M., on paper ruled to a scale, having each distance written and marked on the horizontal scale at its height. From a diagram through these marks, the eye can detect any error in the measurements or in the curves of areas, and their correction may be secured, on their computation being written on the certificate of survey.

The following dimensions, particulars, space and displacement are to be recorded on register, and the seven forms of transfer, mortgage, &c., in bill:—

Length of weather deck at its medium height .... 138·9 feet.
Depth from deck to rabbit in keel .... 17·2 feet.
External bulk to medium height of deck........................34·612 cubic feet.
Internal space to under side of deck ... 23,010 ratio to bulk, ·665
Cubical contents of hull, including lower deck, 11,602 ratio to space, ·504
Mean of external bulk and internal space, cubic feet 28,811 ÷ 35 = 825 tons.
Do. do. X factor ·30 = Register, 246 94-100 tons.
Length between perpendiculars at rabbits in stem and stern post, 2-3rds height, 133 feet } ratio of { Length to breadth 5·5
Breadth at ditto, 24 feet........................ } ratio of { Depth to breadth ·67
Displacement immersed to upper deck ....938 tons, 18·4 high.
Ditto to load water line or 2-3rds height ....538 ,, 12·4 ,,
Ditto light water line or 1-3rd height......................159 ,, 6·2 ,,
Area of midship section, height of deck ....346 square feet.
Ditto ditto 2-3rds, height of deck ....288 ,,
Ditto ditto 1-3rd, height of deck .... 69 ,,

The strength of vessels, so far as regards their safety, may also be ascertained by recording on the certificate of survey a specification in detail of the materials as shown in the certificate survey of the 350-ton vessel, from which the weight of the hull of a timber ship is estimated to be 184 tons, that of iron 138 tons. The exact space occupied by the hull can be measured by setting off the thickness of timber and plank and iron at measured sections on a scale, which not only shows the disposition of material and strength, but enables the surveyor or owner, from one measurement, to compute both the external bulk and internal space; the former affording information as to form, proportions, and dead-weight cargo carried; the latter, the capacity for light goods, their difference being the cubic contents of the hull, as shown above, for a timber vessel to be 11,662 cubic feet, its ratio to the internal space being ·504, or one-half, while that of an iron vessel is only ·367, or the hull little more than one-third.

The new Act adopts the internal space as the basis of registered tonnage, using 100 as the divisor, by which a vessel of the same dimensions and bulk would be registered only 230 tons if built of timber, but 268 tons if built of iron. As much more equitable, it is proposed to substitute for this the mean of the external bulk and internal space, as before mentioned. The same vessel built of timber on Lloyd's specification, or entirely of iron, using the factor ·30 hundredth, their registered tonnage would be 247 and 263 tons respectively.

These propositions, like Mr. Moorsom's, were again addressed to the Board of Trade in November 1852, suggesting the reorganization of the Tonnage Committee, and the addition of Members connected with shipping and with scientific societies, so as to promote free discussion and the improvement of the Mercantile Marine.

In December 1853, it was discussed at the Institution of Civil Engineers, and application was made to the Board of Trade that the plan might be submitted to the Local Marine Boards and shipowners. This request was not complied with, the internal measurement proposed by Mr. Moorsom being adopted, instead of the external mode recommended by the Tonnage Commission.

Mr. **Keogh** exhibited and explained the construction of a new kind of power-loom, in which two looms are fitted into a single frame, one loom being above the other. The advantages stated to be gained by this arrangement are increased space and greater œconomy in the manufacture.

On some Experiments upon a Telegraph for communicating across Rivers and Seas, without the employment of a submerged Cable.

By J. B. LINDSAY. (*Communicated by* RICH. B. GRANTHAM, *C.E.*)

Mr. Lindsay's proposition or invention consists in communicating intelligence through rivers and seas without the use of a submerged cable.

An experiment was tried on a small scale in the middle of last month across the mill-dam at Portsmouth, in the presence of Capt. Beattie, Royal Engineers, and other engineering officers: the distance was 536 feet. The next and last experiments were made across the entrance to the harbour at Portsmouth, one distance being 600 yards and the other 1380 yards.

He placed along upon each shore a copper wire, to both ends of which he attached a sheet of copper, one pair of these sheets being opposite to the other pair upon the shore. All the other four sheets were immersed in the water, but they were not isolated. Upon one line of wire the battery was placed, and upon the other the telegraph; and upon the battery being brought into action, the needles were put in motion on the opposite shore.

Mr. Lindsay considers that the distance between the copper plates on each shore ought to be equal to the sum of the two widths across the river or sea at the plates; but by increasing the strength of the battery, or enlarging the area of the copper plates, the plates can be brought nearer to each other.

In the last experiments the distance across two of the plates was said to be 600 yards, and the other distance 1380 yards. One of the plates was laid at Blockhouse Fort, and the other at the round tower at Sallyport.

One very surprising feature in these experiments was, that although the 'Stirling Castle,' a two decker, was moored near to the plate on the north of Blockhouse Fort, and beside her a frigate hulk for convicts, and also the 'Sealark' brig, and these ships were nearer to the plate at Blockhouse Fort than the distance from those ships to the plate on the opposite shore, the communication was not in the least degree interfered with. These ships were all copper-bottomed, and they were in close vicinity to the 'Victory,' and many others, but they were on one side, and not in the direct line of communicatiou.

There is, besides the copper of the ships, the iron chains by which the floating bridge is drawn across the harbour; and still, with all these incitements to draw off the electric fluid, there was no interruption of the current in its course to the needles.

Judging from the results of these experiments, Mr. Lindsay believes that there is scarcely any limit to the employment of this kind of telegraph; and if he had the opportunity, he would not fear to extend it across much wider spaces than have hitherto been attempted.

These experiments show that intelligence can be transmitted across rivers and seas, and that this kind of telegraph may be used for communicating across rivers in populous places, where there may be large numbers of vessels passing and repassing; but if upon the larger scale, across seas from one kingdom to another, a vast improvement will be attained as compared with the present system by submerged cables, liable to many accidents, and probably undergoing a vast amount of depreciation.

Mr. E. M'DERMOTT explained a new railway brake, which is brought into action by the pressure of the steam in the boiler.

On a Method of Boring Holes in Rock for Tunneling Purposes.

By J. NASMYTH, *F.R.S.*

In the ordinary method of boring holes for blasting, by striking at the end of the bar with heavy hammers, a great portion of the effect is lost by what is commonly termed the "inertia" of the bar. To overcome this defect, Mr. Nasmyth proposes to convert the bar into a piston-rod, to work in an air-tight cylinder through a stuffing-box. By this means, when the piston is drawn to the end of the cylinder, the pressure of the atmosphere will force it back again with accumulating velocity, and the blow struck will have much greater effect. Mechanical contrivances might be introduced for changing the shape and the directions of the penetrating point. It was suggested in the discussion that ensued, that a similar effect might be more readily produced by the employment of vulcanized india-rubber springs. Mr. Nasmyth observed, that any elastic medium would answer the purpose; but air suggested itself as affording greater extent of spring.

Mr. NASMYTH explained a plan for destroying ships by means of a marine mortar fixed at the bow of a strongly built vessel to be propelled by steam-power. He proposed to place in the bow of the vessel, and projecting about 2 feet beyond it, a case large enough to contain about six hundredweight of gunpowder. A percussion ball was to be inserted at the back of the reservoir of gunpowder to explode at the instant that it struck against the ship to be destroyed. The mortar vessel was to be built of blocks of timber, so strongly as to be able itself to resist the effects of the explosion, which would completely destroy the enemy's ship. Such a marine mortar, it was stated, could be amply manned by "three brave fellows," who would be secured from danger by the strength of the ship and its recoil, and by then occupying positions least exposed to injury, even should the explosion do damage to the parts nearest to it.

Mr. NASMYTH described a Lightning Conductor for Chimneys, which he conceived affords more perfect insulation, and is therefore safer than those in common use. The present practice is to fix the conductor outside the chimney by metal holdfasts, by which means, during severe thunder-storms, chimneys are often damaged by the lightning entering at the points of attachment and displacing the bricks. In the method of fixing the conductor recommended by Mr. Nasmyth, the metal rod is suspended in the middle of the chimney by branching supports fixed on the top. A conductor of this kind had proved efficient in storms which had severely injured other chimneys in the neighbourhood that were protected in the usual manner. An experience of eighteen years had tested the superiority of the plan*.

Capt. J. NORTON described some railway signals, which he considered might be adopted with advantage for effecting communication between the guard and the engine-driver. One of these, which he said was of Chinese origin, consisted of a metal whistle fixed to a short stick, which when thrown rapidly through the air, made a shrill sound. Capt. Norton said, the best means of propulsion was to fire it from a pistol. He had tried it several times with great success; for the engineer, when he heard the whistle passing over his head, responded immediately by sounding the steam-whistle.

---

* Prof. Faraday, on being called on for his opinion, said that he had no objection to lightning conductors being placed inside as well as outside of buildings. The lightning conductor attached to the Duke of York's pillar is fixed outside, to the great disfigurement of the column; he would have placed it inside. All masses of metal near the conductor are bad, unless there be a continuous line of conduction to the ground. He mentioned the instance of damage done to a lighthouse in consequence of part of the discharge of lightning having passed from the conductor to the unattached lead fastenings of the stones. So a practical question for consideration by the Mechanical Section was, how far they could safely run lead between the stones of such a structure; for if it were done partially, leaving a discontinuous series of such metallic fastenings, there would be great danger of the stones being displaced by the electric discharge. When such fastenings are used, care should be taken that they are connected together and with the earth by a continuous metallic conductor. Some persons conceived that it is desirable to insulate the conductor from the wall of a building by glass, but all such contrivances are useless, since the distance to which the metal could be removed from the wall by the interposed insulator was altogether insignificant compared with the distance through which the lightning must pass in a discharge from the clouds to the earth. On being asked whether a flat strip of copper was not better than a copper rod, Prof. Faraday said the shape of the conductor is immaterial, provided the substance and quality of the metal are the same.—[Note by EDITOR.]

On Unchanged Steam. By Mr. PROSSER.

The author explained and commented on the plan adopted in the 'Arctic' steam-packet, of giving additional heat to the steam on its passage to the cylinders by exposing it more directly to the action of heat.

On the Means of realizing the advantages of the Air-Engine. By WILLIAM JOHN MACQUORN RANKINE, *Civil Engineer, F.R.SS. Lond. & Edin. &c.*

This paper consists of four sections. In the first are explained the two fundamental laws of the mechanical action of heat, and their application to determine the efficiency of theoretically perfect engines, working between given limits of temperature; and it is shown that, as the efficiency increases with the distance between those limits, and as it is easy to employ air with safety at temperatures far exceeding that at which the pressure of saturated steam would cease to be safe and manageable, the maximum theoretical efficiency of air-engines, consistent with safety, is much higher than that of steam-engines; for example, at the temperature of 650° Fahr., at which the air-engine has been successfully worked, the pressure of saturated steam is 2100lbs. on the square inch, while that of air is optional, being regulated by the density at which the air is employed.

In the second section the various causes of waste of heat and power in steam-engines are classified, and the actual efficiency of steam-engines is compared with their maximum theoretical efficiency, and also with the maximum actual efficiency which may reasonably be supposed to be attainable in the steam-engine by means of any probable mechanical improvements.

The following are estimates of the consumption of bituminous coal of a specified quality per horse-power per hour :—

1. For a theoretically perfect engine, working between such limits of temperature as are usual in steam-engines .... 1·86lbs.
2. For a double-acting steam-engine improved to the utmost probable extent .... 2·50 „
3. For a well-constructed and properly worked ordinary double-acting steam-engine on an average .... 4·00 „

In the third section the causes of waste of heat and power in air-engines are classified in a manner analogous to that applied to steam-engines, and the actual efficiencies of those previous air-engines as to which satisfactory experimental data have been obtained, namely, Stirling's engine, and Ericsson's engine of 1852, are compared with the efficiencies of theoretically perfect engines working between the same limits of temperature, the results being as follows, so far as they relate to the consumption of coal of the specified quality, per horse-power per hour :—

	Actual consumption.	Consumption of a theoretically perfect engine.
Stirling's engine	2·20lbs.	0·73lbs.
Ericsson's engine of 1852	2·80lbs.[*]	0·82lbs.

It is thus proved that an air-engine has actually been made to work successfully, and to realize an œconomy of fuel considerably superior to that of ordinary steam-engines, and, in fact, surpassing the utmost limit to which it is probable that the œconomy of double-acting steam-engines can ever be brought.

Stirling's engine, as finally improved, was compact in its dimensions, easily worked, not liable to get out of order, and consumed less oil, and required fewer repairs than any steam-engine; still the advantages shown by that engine over steam-engines were not so great as to induce practical men to overcome their natural repugnance to exchange a long-tried method for a new one. Another circumstance caused Stirling's and Ericsson's engines to meet with neglect from scientific men, namely, that both were by some persons represented as instances of *power created out of nothing*,—the popular delusion commonly called "*the perpetual motion.*"

---

[*] The fuel consumed in Ericsson's engine was anthracite, at the rate of 1·87 lb. per indicated H. P. per hour, according to Prof. Norton's computation. This quantity is here multiplied by 1·5, to reduce it to the equivalent quantity of bituminous coal of the quality contemplated in the other calculations of this paper.

It is shown that Stirling's air-engine, as compared with a theoretically perfect air-engine, wasted two-thirds of its fuel, and Ericsson's somewhat more.

Two obvious and powerful causes of that waste of fuel are traced,—

1. Deficiency in extent of heating surface;

2. The communication of heat from the furnace to the working air, at those periods of the stroke when it is not performing work.

The necessary conclusion is, that the more completely we remove those two causes of waste of fuel, the more nearly shall we approximate to the theoretical extent of the œconomy of the air-engine, an extent far exceeding that to which the œconomy of the steam-engine is restricted; and the more fully, in short, shall we accomplish that which has hitherto been very imperfectly done; *i.e.* REALIZE THE ADVANTAGES OF THE AIR-ENGINE. [These first three sections have been published in the Edinburgh Philosophical Journal for January 1855.]

The fourth section describes the improved air-engine of Messrs. James Robert Napier and W. J. Macquorn Rankine. In this engine the heating surface is increased to any required extent by means of tubes employed in a peculiar manner. The waste of heat, from its communication to the air at improper periods of the stroke, is prevented by a sort of plunger, or combination of plungers, called the *Heat-screen*, which prevents any access of the air to the heating surface, except when it is in the act of expanding, and so performing work. The engine may be made of the same size with a steam-engine of the same power, or smaller, according to the degree of condensation at which the air is employed.

Independently of the amount and value of the saving of fuel which will result from the introduction of the air-engine, it possesses the important and incontestable advantage, that even should an air-receiver burst (which is very unlikely), the explosion would be harmless, for its force would not be felt beyond the limits of the engine itself, and hot air does not scald.

Dr. REID presented a sketch of the plan of ventilating St. George's Hall; and at the conclusion of the sitting he accompanied the members over the building to show the arrangements.

On the Progress of Naval Architecture and Steam Navigation, including a Notice of the large Ship of the Eastern Steam Navigation Company. By JOHN SCOTT RUSSELL, *C.E., F.R.S.*

Mr. Russell explained the elementary principles which guide the construction of ships, and condemned the legislative restrictions which, till within the last twenty years, prevented the application of those principles. The old "sea chests," which were constructed with a view to avoid the taxation imposed on ships that were not built of certain shapes, possessed neither the requisite properties of stability nor windwardness, and were very slow; they were built solely with a view to hold the greatest amount of cargo within a given superficies, without regard to the other qualities of a ship. In smuggling and piratical vessels the true principle of ship building, for acquiring speed, had however been long introduced before the subject was taken up by the British Association, and the wave principle of construction had thus been established by extended experiments on a large scale. A fine concave entrance, instead of a bluff round bow, is now generally admitted to be the best; and, in addition to the shape of the water line, it had been found that length of the body of a ship facilitates its passage through the water, by allowing a longer time for the particles of the fluid to separate. A ship with a fine concave bow, a long body, and a comparatively round stern, Mr. Russell said, cleaves its passage through the water without raising a wave in front to obstruct its course. No steam-ship that is not 180 feet long can be propelled at a speed of sixteen miles an hour without a great expenditure of power; and 400 feet is the shortest length for a ship that is intended to be propelled at so high a speed as twenty-four miles an hour. As an illustration of this rule, it was mentioned that the 'Himalaya,' which is 365 feet long, attains the greatest speed for the power employed of any merchant ship. In the construction of large ships, however, the builders were met with the difficulty of not being able to find wood of sufficient size for the requisite strength, since no means have yet been invented of joining pieces of wood together so as to give them the same strength as the whole timber. This want of material of sufficient size was supplied by using iron, for the joints can be made as strongly as the whole plate, or plates of metal of any required size can be rolled for the purpose. This facility of increasing the size of the material is the principal advantage derived from the use of iron, which affords facilities for constructing ships of any size; and it is of that material that the great ship, now building in London for the Eastern Steam Navigation Company, is to be constructed. Mr. Russell complimented Mr. Brunel for the engineering skill and ingenuity he had displayed in leading the way in the construction of large iron ships; and he alluded to the forebodings of disaster on former occasions, when the 'Great Western' and the 'Great Britain' were built, which forebodings events had shown to be groundless; and he felt confident that the similar forebodings which some people had expressed of the still larger ship now being built would be equally fallacious. Mr. Russell said he wished it however to be understood, that he did not recommend the general adoption of such large ships. The size of the ships ought to be suited to the traffic and the distance; but the point he contended for was, that it is only by employing very large ships that steam-navigation to distant parts of the globe can be profitably carried on. A steam-ship to Australia, if it were not large enough to carry sufficient coal for the voyage, had to take in a supply over and over again, and at each station the cost of the coal was increased by conveying it to the different stations. Under such disadvantages no freight could pay the cost of conveyance; and in order to remove them, it was necessary to build a ship of sufficient size to carry a supply of fuel for the voyage out and back again, or equal to circumnavigating the globe. An extremely fine entrance was another of the characters which the large ship now building would possess, so as to enable it to move through the water with the greatest attainable velocity with a moderate amount of steam power. With these advantages it was expected that the ship would accomplish the voyage to Australia in thirty or thirty-three days. It would easily carry 6000 tons, besides its requisite quantity of coal, and would have excellent accommodation for 500 first-class passengers, 600 second-class, and 1000 third-class passengers. It would be 675 feet long, 83 feet in breadth of beam, and 60 feet deep; and though so large that St. George's Hall is small in comparison, it is the smallest size that could do the work required with speed and œconomy.

On Mechanical Appliances on board Merchant Ships. By Mr. Saxby.

Inquiry as to the Principles and Measures on which Safety in the Navigation of Iron Ships may be reasonably looked for. By the Rev. Dr. Scoresby.

Dr. Scoresby alluded to his previous communications on the deviations of ships' compasses by the influence of the masses of iron in iron ships, and said, that after experiencing much opposition, his views had been fully confirmed by Mr. Archibald Smith, a gentleman who had at command all the records of her Majesty's ships. The principles for which he contended were:—

1. That the magnetism of iron ships in its action on the compass may be represented by a vertical and a horizontal bar swinging round a compass.

2. That changes in the magnetic distribution and compass action in iron ships do take place.

3. That changes take place in a ship's magnetism by changes of magnetic latitude.

4. That there are influences in a ship derived from the varieties of form and position (relatively to the compass) of particular masses of iron which may act as natural correctives.

5. That the plan of correcting the deviation in iron ships by fixed magnets is unsafe, and in going to southern regions aggravates the error.

6. That the twisting and straining of the iron materials of a ship will tend to alter the magnetic action on the compass; and,

7. That, whilst changes are not unfrequently rapid on occasion of blows from the sea, ordinarily it requires time to effect the changes in a ship's magnetic action.

Dr. Scoresby said, the results of these principles establish the propositions for which he has long contended, that the magnetism of all iron ships is changeable; and that the iron ships in which the least changes may be expected to occur are those which have been long in use ordinarily pursuing the same course, and those not making voyages further south than the Mediterranean. In such circumstances, an intelligent captain, by observing the changes that take place, may generally have confidence in his compasses. The suggestions which Dr. Scoresby made for diminishing the danger arising from deviations are,—that a standard azimuth compass be placed on a pedestal on deck where a position of smallest deviation may be found; that a compass be placed at the masthead for reference to correct errors; and that care be taken on the selection of compasses to have ample directive force in the needle.

On Steam-boiler Explosions. By JOHN SEWELL, *Assoc. C.E.*

On the Origin of Wire Rope; its Qualities and Œconomy.

By ANDREW SMITH, *London.*

In the year 1848, the British Navy had in commission only 376 ships of every class; at the present time there are in commission more than double that number. The expense for hempen rope standing rigging for the above number of ships (hempen rope being at the rate of about £40 per ton) amounted to about £114,330. At that time patent wire rope was £60 per ton; but in consequence of wire rope being more than twice as strong for the same weight of hempen rope, the cost for the standing rigging of the above number of ships, made of wire rope, amounted to about £86,000, thus showing a saving of about £28,000 for one outfit of the Royal Navy at that time; but now hempen rope is about £80 per ton, instead of, as it was then, in 1848, £40 per ton. The Royal Navy is now supplied with wire rope at the rate of £40 per ton. Now, as that supply is more than doubled in consequence of the great increase of the Royal Navy, and as hempen rope is now about £80 per ton, the same number of ships would cost £228,660; and as there is more than double the number of ships in commission at this time, and as the price of hempen rope has doubled also, and if there had been no wire rope, the Royal Navy would have cost the country for one outfit of standing rigging £914,640;—now it follows, that as wire rope is only £40 per ton, instead of £60, as it was in the year 1848, the saving now effected by the invention of wire rope, as applied to the standing rigging of the Royal Navy, is about £457,320 for one outfit, without taking into account that it is much more lasting or durable. Speaking from the length of experience, which is nearly twenty years, it may be taken as three times more durable; in fact, unlike hemp, the older the wire is the stronger it gets. Several ships in the Royal Navy have been fitted from fifteen to sixteen years with this rope, and it is now as good as when first put over the masthead. Hempen rope in the Royal Navy is fitted every three years, or every time that the ships are put in commission; in the port of Liverpool a great number of vessels have been fitted with this rope about fifteen years; consequently if it is admitted to be three times more lasting or durable than hempen rope, there would be a saving effected in three commissions, or nine years, for the standing rigging of the Royal Navy, amounting to the sum of £1,371,960. The merchant service is using quite as much now of this important manufacture as the Royal Navy; and its application for mines, railways, submarine-telegraph cables, &c., is very great. There are at this time about twenty different establishments for producing this important and now staple manufacture in Great Britain; and if the average produce at each establishment be taken as five tons per day, they make 100 tons per day. If the average price be taken as £50 per ton, this will amount to upwards of £1,500,000 sterling per annum. Copper wire rope is now very extensively used for lightning conductors, and was first introduced for the purpose by the author of this paper.

On the Limit of Weight which may safely be laid on a Pile driven into the Ground. By Professor STEVELLY, *LL.D., Belfast.*

The force which resists the penetration of a pile may, under very peculiar circumstances, diminish as the pile is driven downwards; but for the most part it increases, and generally towards the last strokes it receives from the ram the increase is very considerable. A simple test for this was pointed out by the author, viz. after the pile had been driven as deep as intended, letting the ram descend on it from a less height than the previous stroke, and carefully comparing the two distances it has been thus driven. If the resistance increase, then the actual load the pile can bear will not be less than what it would be if the resistance were strictly uniform which the pile experienced as it penetrated. This last force admits of a very simple calculation; from which, therefore, a most certain limit to the load or dead weight that can be laid on the pile without its sinking further may be obtained. The author then pointed out the two dynamic principles on which the calculation was founded:—1. When a moving mass, W, strikes another W′ at rest with the velocity v, then the velocity, after impact,

$$v' = v\frac{W}{W+W'}.$$

2. When a body, moving with the velocity v', is stopped by a uniformly acting resistance, that resistance can be compared with the weight that gives the velocity (say to the ram), by the principle that the force or resistance is proportional to the square of the velocity gained or destroyed, divided by the space through which the force acts to give or take it away. The following practical rule is, then, a simple algebraic deduction from these two principles. Let W denote the weight of the ram in tons; W′ the weight of the pile in tons and decimals; h, the height in feet and decimals from which the ram is let fall on the final stroke; d, the depth in decimals of a foot which the last stroke causes the pile to penetrate. L, the limit of load (in tons) that may with safety be laid on the pile, shall then be,—

$$L = W \cdot \left(\frac{W}{W+W'}\right) \cdot \left(\frac{h}{d}\right);$$

in which W, W′, h and d, can all be had by actual weighing and measurement.

On an improved Printing Machine. By J. STATHER.

Mr. J. TAYLOR made a communication "On an Iron Floating Graving Dock;" by which means the ships to be repaired are raised by caissons of a peculiar shape.

A Report of Experiments on the Friction of Discs in Water and on the Experiments to be made on Centrifugal Pumps. By J. THORNTON.

APPENDIX.

On the Amounts of, and Methods of Estimating, Ammonia and Nitric Acid in Rain-water.

By J. B. Lawes, *F.R.S., F.C.S.; and* Dr. J. H. Gilbert, *F.C.S.*

[The following Paper, containing the numerical results relating to ammonia,—but not those referring to nitric acid, which the authors exclude, after reserving them for re-examination since the Liverpool Meeting—is given as supplement to the abstract at pp. 70, 71, and is added by direction of the Council.]

The character and amount of the extraneous matters in rain-water are questions of interest in so many points of view, that little apology need be made for recording, under the auspices of the British Association, any additional information on that subject. Of all such extraneous matters, the ammonia and nitric acid are of importance in the most numerous aspects. Thus, their existence in the atmosphere, from which they are washed by the rain, is primarily dependent, largely at least, on the emanations from the surface of the earth, resulting more or less directly from the decomposition or combustion of animal and vegetable substances, and the transformation of the animal substance by the vital process. Their amounts therefore must be greater or less in the lower strata of the atmosphere, according to the local prevalence of animal life and other causes, whilst the relative amounts of the two, especially in the higher strata of the atmosphere, will be dependent on its meteoric or electrical condition. Again, whatever may be their source or amount, or their proportion to each other in the atmosphere itself, the amounts of them which are carried down in rain and the minor aqueous depositions from the atmosphere in any given locality, over any fixed period of time, or according to other circumstances, must be of interest at once in a sanitary, a meteorological, and in an agricultural point of view.

It is to Cavendish that we are indebted for the observation, that ammonia and nitric acid are formed when humid air is submitted to voltaic action. About the commencement of the present century, De Saussure detected ammonia in the atmosphere. A few years later, Chevreul observed its presence in the Seine; and in 1825, Brandes detected it in rain-water. Since that time much more minute attention has been paid to this subject, and also to the presence of *nitric acid* in rain and other waters. Liebig and Boussingault have particularly called attention to the influence which the ammonia carried down from the atmosphere must have upon the growth of plants; and the former of these philosophers pointed out the occurrence of nitric acid also, in a considerable number of rain-waters which he examined, especially in those of thunder-storms; though to the *amount* of nitrogen so brought down he attached little importance. Dr. H. Bence Jones has also found nitric acid in the rain which fell in various parts of England and in the south of Ireland.

But it is to the more recent labours of Boussingault that we are indebted for our most elaborate *quantitative* estimations of the *ammonia* in rain and other waters; and M. Barral has made a series of quantitative determinations of the *nitric acid* as well as the ammonia, contained in the rain which fell at Paris during several consecutive months in 1851. Our own object in entering upon the same field of inquiry, was chiefly with a view to the agricultural bearings of the subject. But the conduct of an investigation involving at once the treatment of large bulks of material and the determinations in them of infinitesimally small amounts of the substances sought for, is attended with many practical difficulties: and the scope and object of the present paper is rather to discuss the methods of analysis, than to rely with confidence on the conclusions to which we might be led by the direct application of the numerical results yet obtained, to the solution of the several important scientific and practical questions upon which they bear.

In the Tables which follow are given the results obtained in the estimation of *ammonia* in rain-water by several different methods. In the first instance, very large amounts (from 100 to 200 lbs. or more) of rain-water, to which a little caustic potash was previously added, were distilled, and the distillation of the product repeated, collecting in each case about one-half the amount put into the retort, until the whole was reduced to a convenient bulk for further treatment. This was then evaporated in an open vessel, with a known amount of sulphuric acid *to a given volume*. Measured portions of this acid product were then neutralized by a standard alkaline solution, in the usual manner of liquid analysis. This process we designate as "Method 1."

The system of graduation adopted throughout the experiments was that of septems, this being generally employed in water analyses in Great Britain. As cubic centimetres and litres are generally adopted abroad, it may facilitate the conception of those accustomed to the latter measures, to state, that the septem is equal to 7 grains of water at 60°; that 1000 septems is equal to a decigallon, or 1 lb.; and 10,000 septems consequently are equal to 1 imperial gallon. A cubic centimetre, on the other hand, is equal to 1 gramme, or rather less than 15½ grains; and 1000 cubic centimetres, or grammes, are equal to 1 litre. Consequently, for the purposes of a general conception merely, a cubic centimetre may be considered as equal to 2⅕th septems, and a litre to 2⅕th decigallons or lbs. avoirdupois. We shall, however, always give the amount of ammonia found in *one million* parts of rain-water, which is precisely equivalent to the scale of milligrammes of ammonia per litre (1,000,000 milligrammes) of water, as adopted by MM. Barral, Boussingault and others. The sulphuric acid used in the determinations made by *Method* 1, was at "10°" strength, 1000 septems of which contain 50·1 grains (one-tenth the combining number) of the dry acid; 1 septem, therefore, of this liquid acid contains 0·0501 grain of the dry acid, and is equivalent to the neutralization of 0·02145 grain of ammonia, which is = $\frac{1}{10,000}$th of Berzelius's number for ammonia. The acid was prepared by dissolving 66·73 grains (one-tenth the combining number) of pure carbonate of soda in 1000 septems, or a decigallon, of distilled water at 60°, and then making a previously dilute acid to exactly the same strength, volume for volume, by the usual alkalimetrical method; and, from this acid at 10°, the standard caustic alkali solutions were made of a like strength, in a similar manner. The above acid is exactly one-seventh the strength of Peligot's acid.

In Table I. which follows, are given the results of the determinations of the ammonia by this "*Method* 1," in the mixed sample for each month, of the rain which fell in March, April, May, June, July and August of 1853. The quantities operated upon were one-half or one-fourth of the total amounts collected in each month in a rain-gauge of exactly $\frac{1}{1000}$th of an acre area (43·56 square feet).

TABLE I.

Method 1.—The Rain twice distilled to $\frac{2}{3}$ths with a little caustic alkali, and the second distillate evaporated with sulphuric acid to the measure of 1000 septems. (Year 1853.)

Months.	lbs. of rain distilled.	Septems of sulphuric acid at 10° added to second distillate.	Septems of alkali at 10° to neutralize 100 septems of concentrated acid product.	Difference = septems ammonia at 10° in 100 septems acid product.	Grains of ammonia in rain-water taken.	Ammonia per million of rain-water.
March ...	267·2	300	17·5 17·5	12·5 12·5	2·681	1·433
April	169·6	400	35·5 35·5	4·5 4·5	0·965	0·812
May	95·2	300	25·5 25·5	4·5 4·5	0·965	1·448
June	175·2	700	62·0 62·0	8·0 8·0	1·716	1·399
July	213·0	500	43·5 43·5	6·5 6·5	1·394	0·935
August ...	167·9	400	35·5	4·5	0·965	0·821

It is seen that the smallest quantity of water submitted to distillation in this series of experiments was about 95 lbs., and that the largest was about 167 lbs. To the second distillate of $\frac{2}{3}$ths of the amount put into a retort of glass with a little caustic alkali, the quantities of sulphuric acid at 10° given in column 3 were added, and the whole was then evaporated to the measure of 1000 septems at 60°. One-tenth of this, or 100 septems, after being coloured by a given measure of infusion of litmus carefully freed from excess of alkali, was then tested with a caustic alkali solution, also at 10°. It was invariably found, that, with liquids of this degree of concentration, the determination could be made to a single drop of the test alkali. This would give a maximum range of error of about $\frac{1}{50}$th, or 2 per cent. of the whole ammonia contained in the water, dependent on the manipulation of the test liquors. It was still a question whether there might not be some source of error, either in assuming with M. Boussingault that the whole of the ammonia would be obtained in a $\frac{2}{3}$ths distillate, or in supposing that there would be no loss either of ammonia or of acid, in the evaporation of the acidulated distillate in open vessels. By the comparison which will presently be made, however, between the above determinations by Method 1, and others in specimens of the same waters by Method 2, which in fact is that adopted by M. Boussingault, it will be seen that there was probably no error due to either of the causes just suggested. In fact we conceive that the method of large distillation, with subsequent acidulation and concentration of the distillate to a given measure of fluid, and the use of comparatively strong test liquids, is capable of giving very good results; but it was necessarily abandoned from the great practical inconvenience, and frequent breakage, in conducting distillations in glass on so large a scale.

In the next Table (II.) are given the actual results obtained by Method 2; which is substantially that of M. Boussingault. M. Boussingault's process consists in submitting to a single distillation, generally not more than 1 litre (about 35¼ ounces) of water, and collecting and testing by the alkalimetrical method, two or more successive fifths or tenths of the product. For this purpose M. Boussingault uses a test acid little more than $\frac{1}{6}$th the strength of our acid at 10°, and only $\frac{1}{40}$th the strength of the test acid of M. Peligot. His test alkaline solution, again, is not quite $\frac{1}{3}$rd the strength, volume for volume, of his test acid. In practice he finds that the limit of error in the use of this dilute alkaline solution is about 0·2 cub. cent. measures of it, equal to about 0·033 milligramme, equal to 0·0005 grain of ammonia. This, equal to about $\frac{1}{2000}$th of a grain only, is certainly a surprisingly small *actual* amount of ammonia to determine by analysis; but when it is considered, that in the quantity of water operated upon by M. Boussingault, there is seldom 1 milligramme=0·0154 grain of ammonia, it is obvious that an error of only 0·033 milligramme, or 0·005 grain, however small in *actual* amount, is still considerable in relation to the whole to be estimated, amounting in the case supposed to about $\frac{1}{30}$th or 3$\frac{1}{3}$rd per cent. But when we further consider, that the total amount of ammonia in a litre of water is frequently considerably less than a milligramme, and also that this total amount, whatever it may be, is divided for testing into two or more separate portions of the distillate, it is obvious that the minimum range of error, especially in the testing of the weaker portions, must be very considerable indeed in proportion to its whole amount. We have however had the privilege of witnessing the conduct of the process in the hands both of M. Boussingault and of his able assistant M. Houzeau, and certainly with surprising uniformity of result.

In Table II. are given the actual results of experiments in the Rothamsted Laboratory, in which 60 ounces, instead of only 1 litre, were generally submitted to distillation: and although the greatest care was taken, it must be admitted that in these first results of unpractised hands, neither was the relation of the ammonia in the successive portions of the distillate so uniform as in the experiments of M. Boussingault, nor were the total amounts of ammonia found in duplicate specimens of water so coincident as could be wished. But it must be clearly understood, that attention is called to this point not in the least with the view of depreciating the admirable labours of M. Boussingault, which we are satisfied have been conducted with the utmost accuracy of which the process is capable, but it seems desirable to point out how serious may be the proportional error in less constantly practised or less careful hands.

It should be mentioned, that in our conduct of this Method 2, in all cases excepting for the month of April, a test acid of 1° strength only was employed; that is to say, $\frac{1}{10}$th the strength of that used previously, and it was moreover only about $\frac{3}{5}$ths the strength of Boussingault's acid. The test alkali, on the other hand, was, for the rain of the first four months, at 1°, and afterwards at only $\frac{1}{2}$° strength, which latter is very nearly identically the same as that used by Boussingault. We sought to measure too, to a $\frac{1}{4}$th of a septem of the stronger, and $\frac{1}{2}$ a septem of the weaker alkaline test-liquor, which respectively represented 0·034 milligramme, or 0·00054 grain of ammonia, almost identically the same degree of accuracy as that attained by M. Boussingault in measuring to 0·2 cub. cent. of his alkali=0·033 milligramme of ammonia. The fractional distillates were collected in small flasks marked according to the quantity to be collected, each of which, when filled, was corked up until the series was ready for testing. An equal measure of pure distilled water was then put into a test-glass side by side with the distillates, and to it was added the same measure of litmus and acid as to the rain products. This being neutralized with its exact equivalent of the test-alkali, furnished a guide as to the tint to be aimed at in the other testings, which were then performed as rapidly as possible, to prevent the absorption of carbonic acid from the atmosphere. It was found by numerous trials, that this adoption of a standard—and compared with the method of M. Boussingault somewhat more permanent point of coloration—gave us greater uniformity of result in duplicate experiments with liquids of known strength, than that of taking the point of first perfect diffusion of blue colour throughout the liquid, as adopted by Boussingault; and the test-liquors were therefore arranged accordingly. It should be added, that the rapid diffusion of the alkali through the liquid was favoured by increasing its specific gravity by the addition of neutral sulphate of potash as employed by M. Boussingault for that purpose.

TABLE II.

Method 2.—By the single distillation of small quantities of water (with alkali), and testing successive portions of the distillate according to Boussingault.

Year 1853.	Experiments.	Ounces of rain-water.	Septems of Ammonia at 1° in portions of distillate.							Ammonia per million rain-water.
Months.			1st tenth.	2nd tenth, or 1st fifth.	3rd tenth.	4th tenth, or 2nd fifth.	5th tenth.	6th tenth, or 3rd fifth.	Total.	
April ……	1	30	…	4·0	…	1·0	…	…	5·0	0·817
	2	30	…	4·0	…	1·0	…	…	5·0	
May ……	1	30	…	4·5	…	2·0	…	1·0	7·5	1·225
	2	60	7·0	3·0	2·0	2·0	…	…	14·0	
	3	60	8·0	4·0	2·0	2·0	…	…	16·0	
June ……	1	60	7·5	2·5	1·5	1·5	1·0	…	14·0	1·144
July ……	1	60	5·0	2·5	2·0	1·0	1·0	…	11·5	0·939
August …	1	60	4·5	1·5	1·5	1·0	1·0	0·5	10·0	0·851
	2	60	5·0	1·75	1·5	1·5	1·0	…	10·75	
	3	60	4·75	2·0	1·5	1·25	1·0	…	10·5	
September	1	60	4·5	2·0	1·0	0·5	0·0	…	8·0	0·735
	2	60	4·5	1·5	1·0	1·5	1·5	…	10·0	
	3	60	4·75	2·0	1·5	1·0	0·5	…	9·75	
	4	60	5·0	1·75	1·0	0·5	0·5	…	8·75	
	5	60	4·75	1·5	1·0	0·75	0·5	…	8·5	
October …	1	60	4·75	1·5	0·75	0·5	0·5	…	8·0	0·688
	2	60	4·5	2·25	1·5	0·75	0·75	…	9·75	
	3	60	4·0	1·25	1·0	0·75	0·5	…	7·5	
November	1	60	5·0	1·5	1·25	0·75	0·5	…	9·0	0·803
	2	60	6·0	2·0	1·25	0·75	0·5	…	10·5	
	3	60	6·0	1·25	1·5	0·5	0·75	…	10·0	
December	1	60	12·75	3·25	2·0	1·0	1·0	…	20·0	1·614
	2	60	12·5	3·5	1·5	1·0	1·0	…	19·5	

In reference to the figures of the Table it may be mentioned, that M. Boussingault found that each successive tenth of the distillate contained ¼th the ammonia only of its predecessor, and that the whole appreciable ammonia was generally contained in the first four or five tenths. It is seen that this rule as to the proportional diminution of the ammonia in the fractional distillates is not well borne out in the figures of our Table; and although we do not call in question the fact of this actual relationship in an absolutely uniformly conducted series, yet it would seem that in practice it is not easy to attain it. Nor can we be much surprised at the difference in the amount of ammonia indicated in the "total" column in cases of duplicate analyses, when we remember that each *total* is the sum of the amounts obtained in four or five separate testings, in each of which the minimum error of observation is 0·25 of a septem of ammonia at 1°, and that it requires considerable practice, and some dexterity and accuracy of observation, to avoid a greater range of error. Upon the whole, then, considering that in operating upon only a single litre of rain-water, the minimum error of observation, if any, will even with the most perfect manipulation generally amount to 3 or 4 per cent. of the total ammonia contained in the water, and further, that in any but the most practised and skilful hands the error may be much more than that supposed—indeed more than multiplied by the number of testings—we were led to abandon this second method also, notwithstanding its very obvious advantages so far as convenience and rapidity are concerned. These objections will of course apply with still greater force when rains containing less than the average amount of ammonia are operated upon, and especially in the case of the waters of springs and rivers, the average amount of ammonia in which would seem, according to M. Boussingault, to be very considerably less than in any rain-waters.

In subsequent experiments, therefore, we adopted the plan of operating upon several litres of water in the first instance, reducing the bulk by successive distillations to one-half, until thus brought to a convenient amount for final distillation, and subsequent testing of measured proportional amounts of the distillate in the manner described in reference to Method 2. This modification, we have since observed, was suggested by M. Boussingault himself, but it would seem he did not generally adopt it. In the next Table (III.) are given the results obtained by this *Method* 3, in which 3, 6, or 12 lbs. of the rain-water were first operated upon, these quantities, as the case might be, being reduced to 24 ounces by successive distillations as stated above. This product was then finally distilled, and the distillate fractioned into quarters, the first three of which were separately supersaturated with the test-acid at 1°, and subsequently neutralized by the test-alkali at ½°.

Table III.

Method 3.—Distillations to one-half, until reduced to 24 ounces, redistilled, and successive quarters tested.

Year 1854.	Experiments.	lbs. of rain-water taken.	Septems of ammonia at 1° in				Ammonia per million rain-water.
Months.			1st quarter.	2nd quarter.	3rd quarter.	Total.	
January	1	6	12·5	1·25	1·5	15·25	0·779
	2	6	13·5	0·75	1·0	15·25	
February	1	3	6·5	1·5	1·25	9·25	0·945
	2	3	6·75	1·5	1·00	9·25	
March...	1	3	8·25	0·75	0·25	9·25	0·945
April*	1	12	34·50	1·75	1·0	37·25	0·967
	2	12	35·25	2·25	1·0	38·50	
May ...	1	12	16·5	1·25	1·0	18·75	0·469
	2	12	16·25	1·00	0·75	18·00	

Water.	Tenths.					Total.	per million.
	1st.	2nd.	3rd.	4th.	5th.		
60 ozs.	9·0	1·5	0·5	0·5	0·5	12·0	0·980

* April checked by Method 2.

A glance at the columns of detail of this Table clearly illustrates the fact pointed out by M. Boussingault, upon which this method of determining the ammonia in rain and other waters is based, namely, that in the case of very dilute solutions of the volatile alkali, nearly the whole of it passes over in the first portions of the distillate. We observe, however, that even where the "total" amount of ammonia obtained from duplicate specimens of water is the same, or very nearly so, still the quantities determined in the corresponding fractional parts do not always agree so well. This would seem to indicate that the discrepancy is due to irregularity in the distillation, rather than to error of observation in the testing. It is true, that this method of successive distillations is much more tedious and troublesome than the method of small single distillations preferred by M. Boussingault; and even with it, it would appear, as in one or two cases in Table III., that the difference between the amounts of ammonia determined in duplicate specimens of rain-water, may in practice be nearly as great in proportion to the whole, as that which is assumed to be a not necessarily exceeded range of error in the method of small single distillations. Upon the whole, however, we consider the modification involved in this Method 3, to be practically very important, and that this form of the process of estimation by distillation is much more applicable to this delicate subject of inquiry than either of those which we have previously adopted.

Before leaving the question of *method*, it may be well to enumerate the calculated minimum proportions of error by the different methods, supposing that in Methods 2 and 3 equally with Method 1, this error would necessarily only occur once in a total estimation. This however is not the case; for it is obvious, that in practice it might tend in the same direction in the estimation in each fraction of the distillate. It is on the other hand of course possible, that the error, if it existed, might be counterbalanced among the several fractions.

Taking first Method 1, and supposing one-tenth of the concentrated acid product of 100 litres of water to be finally tested, this would, on the average of the amounts found in the rain at Rothamsted, contain 10 milligr.= 0·1543 grain of actual ammonia. Assuming also, as was found in the practice of the method, that the degree of accuracy easily attainable in the use of the acid and alkaline test liquors at 10°, indicated 0·2 milligr.=0·0031 grain of ammonia, this range of error would obviously amount to $\frac{1}{50}$th, or 2 per cent. of the whole ammonia contained in the product tested: and it should be borne in mind, that so far as the *testing* was concerned, there was no difficulty whatever in obtaining duplicate estimations which agreed absolutely together; so that the amount of error in a series was certainly not more in practice than that supposed. The difficulty with this method however was, as before stated, in the management of such large distillations in glass vessels.

In Method 2, that of M. Boussingault, 0·033 milligr. of ammonia are supposed to be determined, and the amount of water operated upon to be 1 litre. The average amount of ammonia in 1 litre of the rains collected at Rothamsted is about 1 milligr., or 0·0154 grain; so that the minimum limit of error would obviously be 3·3 per cent. of the whole amount in such a case. The average quantity of ammonia per litre found by M. Boussingault in the rain of the open country does not exceed 0·8 milligr.; in which case the minimum error in estimating to 0·033 milligr. would amount to $\frac{1}{24}$th, or rather more than 4 per cent. of the whole. In the water of *rivers*, the average amount of ammonia, according to M. Boussingault, was not quite 0·2 milligr. per litre; upon which, determining only to the same amount as before, the error might be between ⅕th and ⅙th, or about 16·5 per cent. of the whole. In *spring-water*, again, M. Boussingault found generally only about half as much ammonia as in rivers; in which therefore the smallest error in the determination in 1 litre only, would amount to about ⅓rd of the whole.

According to Method 3 again, assuming that 12 lbs. of water (=about 5½ litres) were used, this, taking the average composition of the Rothamsted rains, would contain about 5½ milligr. of ammonia; and determining as we calculated to do, to 0·034 milligr., the minimum error would thus be about $\frac{1}{160}$th, or about 0·6 per cent. of the whole. The probability of accuracy, therefore, so far as the process of liquid testing is concerned, would be greatly in favour of the third method, that of successive distillations.

At the foot of Table III., however, is given the determination of ammonia in the rain of April 1854, according to Method 2, which indicates by the method of small single distillation 0·98 ammonia per million of water, by the side of 0·967, as obtained by the method of successive distillations; figures which coincide sufficiently to give confidence at least in the approximative truth of the results obtained by the two methods. This brings us to a further consideration of the proportions of ammonia found in the rains collected at Rothamsted by the different methods, and of the actual amounts contained in the water which fell over a given area in different seasons; and also to a comparison of our own results with those obtained by other experimenters in other localities.

TABLE IV.—Showing the proportion of ammonia per million rain-water, and the lbs. of ammonia in the monthly rain per acre, in different localities and seasons, determined by different experimenters, and by different methods.

Months.	Ammonia per million rain-water.					lbs. of ammonia per acre.			
	Paris.	Leibfraunberg.	Rothamsted.			Paris.	Rothamsted.		
	1851.	1852.	1853.		1854.	1851.	1853.		1854.
	Barral.	Boussingault.	Meth. 1.	Meth. 2.	Meth. 3.	Barral.	Meth. 1.	Meth. 2.	Meth. 3.
January ...				....	0·779	......	......	......	0·32
February ...				....	0·945	......	......	......	0·20
March			1·440	....	0·945	......	0·77	......	0·11
April			0·812	0·817	0·967*	......	0·55	0·55	0·11
May		0·624	1·448	1·225	0·469	......	0·55	0·47	0·46
June		0·445	1·399	1·144	....	......	1·07	0·88	
July		0·435	0·935	0·939	....	......	0·95	0·96	
August	2·98	1·494	0·821	0·851	....	0·75	0·55	0·57	
September ..	3·84	0·745		0·735	....	1·00	......	0·33	
October ...	1·08	0·721		0·688	....	0·51	......	0·57	
November...	1·17			0·803	....	0·45	......	0·37	
December...	8·38			1·614	....	1·34	......	0·15	
Means...	3·49	0·744	1·142	0·979	0·821	0·81	0·74	0·54	0·24

* By Method 2, 0·980.

In Table IV. are given,—

The amounts of ammonia *per million*, in the rain which fell at Paris during several consecutive months of 1851, as determined by M. Barral;

The proportions determined by M. Boussingault in the open country in Alsace, during several months of 1852;

The proportions in the rain which fell at Rothamsted during several months of 1853, in several cases determined both by Methods 1 and 2; also in that of several months of 1854 determined by Method 3.

And in the second division of the Table,—

The actual amounts of ammonia *in lbs.*, contained in the rain which fell over the area of an imperial acre, in the case of each of the months experimented upon by M. Barral at Paris, and by ourselves at Rothamsted.

Comparing together the determinations of the ammonia per million of the rains collected at Rothamsted in April, May, June, July, and August 1853, made by both the Methods 1 and 2—in the one case dealing with hundreds of lbs. of rain-water, and in the other with only 30 or 60 ounces of it—the coincidences are such as to lead to the conclusion, that such discrepancies as there are, are due to manipulative difficulties and irregularities, rather than to erroneous principles inherent in the methods themselves. In the determinations for May and June, those made by Method 2 are indeed notably below those made by Method 1. But the obvious deviation from the regularity in the proportion of the ammonia found in the different fractional portions of the distillate, as seen in the detail of the determinations given in Table II., compared with that supposed by M. Boussingault to be so uniform, would lead to greater confidence in the estimations made by Method 1. Confidence in the general principles of the various methods is, however, again afforded by a comparison of the determination made in the rain of April by Method 3, with that made in the same water by Method 2 as given at the foot of the Table; the former giving 0·967, and the latter 0·980 parts of ammonia per million of the water.

Trusting, then, as we may do, in the general approximative truth of the results obtained, we find, that taking all the determinations in the monthly rain collected at Rothamsted given in this Table, and which apply to that of fourteen separate but consecutive months, the average amount of ammonia is almost exactly *one part in a million of the rain*. The average of Boussingault's determinations in the open country of Alsace, and extending over six months of the year 1852, from May to October inclusive, is seen to be as nearly as possible ¾ths of the amount found at Rothamsted. The estimations of M. Barral, on the other hand, in the rain collected at Paris during five consecutive months of 1851, from August to December inclusive, give an average of nearly 3½ parts of ammonia in a million of rain-water; and, in subsequent experiments, M. Boussingault has found the ammonia in the rain at Paris to be as great as that observed by M. Barral. There can be no doubt, therefore, of the influence of a large city teeming with animal life, and in which combustion of various kinds is so enormous, upon the proportion of ammonia in the ambient atmosphere, and consequently on the amount of it which will be washed down in the rain.

In what manner, however, locality, strictly so speaking, influences the actual amount of ammonia from surface emanations or otherwise, in otherwise equally open country, is still a question. But in reference to the *proportion* of it in a given amount of rain, it is at any rate interesting to observe, that the variations which we found in the amount of the ammonia in rain of different but entire months, when considered in connexion with the registered amounts of the fall, the direction of the wind, and the general characters of the weather, are perfectly consistent in kind with the results obtained by M. Boussingault in his special examinations of rain falling under different circumstances, of the water of dews, of fogs, &c. Thus, M. Boussingault always found a very obvious connexion between the amount of rain which fell in individual showers, and the *proportion* of ammonia in the water collected; there being more ammonia per million of the water the less the amount of the fall. There was also much more ammonia at the commencement of a shower than at the end of it, and after a drought than in continuously rainy weather; though a comparatively short cessation of the rain was sufficient again notably to increase the proportion in the water collected. In the water of dews and fogs, again, he found the proportion of ammonia was very high.

From the above facts it would seem, that the proportion of ammonia found in the aqueous deposits from the atmosphere was greatly dependent on the amount of those deposits; or, in other words, on the degree in which they diluted the soluble matters brought down by them from the atmosphere. Turning now more directly to the evidence of our own figures in reference to these points, it is at once obvious, that the period of the year has of itself no direct influence on the proportion of ammonia in the rain; for we find that this is three times as great in the water of May 1853 as in that of May 1854; the proportion found in the latter being the lowest, and that in the former nearly the highest, in our entire series of experiments. And that this was directly due in great part merely to dilution, is obvious from the fact, that whilst there was comparatively little difference in the *actual amount* of ammonia brought down over a given area in the two cases, yet with the small *proportion* of ammonia in the rain of May 1854, the fall was nearly three times as great as in May 1853. The largest *proportion* of ammonia throughout the entire series was, however, in December 1853; and here it was that we had also the smallest fall of rain among the whole fourteen months submitted to experiment. But again, with this very large proportion of ammonia *per million of the rain*, there was during this month of December 1853, as is seen in the second division of the Table, very nearly the smallest *actual amount* of ammonia washed from the atmosphere of any case in our series. Bearing in mind these facts, it will be only what would be expected, that we find the highest proportion of ammonia with prevailing northerly and easterly winds, and the lowest with prevailing southerly and westerly ones; but since the former are generally coincident with a low, and the latter with a high amount of rain, any supposed material influence of the direction of the wind might probably much more properly be referred to the amount of the fall, or in other words, to the degree of dilution.

In the same manner, since with storms we have frequently a considerable total fall, whilst with dews, mists, and fogs, the aqueous deposition is comparatively small, any direct influence which the conditions of atmosphere involved in these states of the weather might have (apart from those inherent in the more general character of the season, or of local circumstances), either upon the formation, or emanation, or the slow or rapid condensation of ammonia, or upon the lessening of its amount by its conversion into nitric acid, is not at once obvious on the face of the figures of the Table. Still, a careful consideration of our notes as to the general character of the weather of the different months, taken in connexion both with the proportion of ammonia in the water collected, and with the total amount of it brought down at different seasons over a given area of land, seems to indicate that the prevalence of thunder-storms has not of itself the tendency to increase the amount of nitrogen brought down in the form of ammonia. And, even supposing that the frequent occurrence of storms during the warmer months were found to be coincident with a large actual deposition of ammonia, it might still be a question whether such a result were not dependent on other characters of the season, or the conditions of the lower strata of the atmosphere, and their connexion with the surface, rather than upon those of the higher strata, or the circumstances more directly leading to the development of the storms. At any rate it is worthy of remark, that in the month of May 1854, which was characterized by the occurrence of many, and some very heavy thunder-storms, and by three times the fall of rain of the corresponding month of 1853, we have still a less total deposition of ammonia over a given area, than in either May 1853, or in the average of the other months, the rain of which was experimented upon: and, with regard to the influence, on the other hand, of the minor aqueous depositions upon the amount of ammonia deposited, our notes and figures do not show any increase in the *actual amount* of ammonia so deposited, which could be attributed to them irrespectively of other circumstances, but rather that their more direct effect is upon the *proportion* of the ammonia to the generally less actual amount of water, as already pointed out. But, whilst the proportion of ammonia per million of the water collected is thus seen to depend more on the mere amount of the fall than on the period of the year, it must obviously at the same time be mainly influenced by the total amount of ammonia actually brought down over a given area; and this again would seem to have little direct or uniform connexion, either with the amount of the fall, or with the period of the year merely. Thus, as already stated, with three times as much rain in May 1854 as in May 1853, we have nearly the same, or even rather less total ammonia deposited, with the larger fall: and again, comparing the results of March and April 1853 with those of the same months of 1854, although it is true that in these cases we have the larger total amount of ammonia brought down with the larger fall of rain, it is seen that there is in March 1854 only one-seventh, and in April 1854 only one-fifth, as much actual ammonia deposited over a given area as in the corresponding months of 1853. It is then, as above alluded to, upon other circumstances than either the amount of the fall or the period of the year, that the amount of ammonia brought down by the aqueous deposits from the atmosphere mainly depends.

Turning to the more direct application of the figures to an important agricultural consideration, it may be stated that the amount of *nitrogen* which our experiments showed was brought down in actual solution from the atmosphere in the form of *ammonia*, was adequate to supply but a small proportion of the average annual amount of it contained in the produce of a continuously unmanured plot of ground. We must seek therefore for some other source of the nitrogen in our unmanured crops, than that which is brought down in rain, and in the minor aqueous deposits from the atmosphere, in the *form of ammonia*: and, without here entering into the question of the power of the soil, or of the plants themselves, to take up the ammonia or other nitrogenous compounds from the atmosphere, independently of the amounts which would be brought down in direct solution in water, there seems to be good ground for supposing, that another compound of nitrogen, namely *nitric acid*, is a more liberal supplier of nitrogen to plants from atmospheric sources, than even ammonia itself.

Although, as has been already mentioned, various experimenters have detected nitric acid or nitrates in rain-water, yet it is to M. Barral that we are indebted for the first quantitative estimations of nitric acid in rain-water which could lead to the supposition, that this is probably an important natural or climatic source of supply of nitrogen available for the growth of plants: and scanty as it yet is, still our daily-increasing knowledge as to the occurrence and properties of *ozone* tends to enhance the probability of such a view. It was hence a chief object of this investigation to determine the quantities of the nitric acid as well as of the ammonia, in the rains collected at Rothamsted, and to estimate from these the sum of the nitrogen supplied by both, in relation to the average amount of it yielded in our unmanured crops. Unfortunately, however, in consequence of the difficulties connected with the quantitative estimation of very small amounts of nitric acid, and especially owing to the existence of nitrogenous impurity in some of the re-agents employed, though in proportions which for many purposes of analysis would be immaterial, the results arrived at on this head are by no means satisfactory or conclusive, or such as to justify a record of the numerical results obtained.

The process adopted was as follows. Large quantities of the rain-water were evaporated with an alkaline carbonate several times to dryness, and the solid residue was carefully collected and weighed after drying at 212°. The per-centage of nitrogen in this solid matter was then sought to be determined by Dumas' direct-volume method of combustion with oxide of copper. Not only, however, were the results of duplicate analyses much more discrepant than they should have been, but the actual amounts of nitrogen indicated were in some cases so exceedingly high, that suspicion was raised as to the purity of the re-agents employed; and it afterwards appeared, that the oxide of copper, which had been prepared from the nitrate, was not free from compounds of nitrogen which yielded it up in the combustion. But independently of the error which may have arisen from this cause, it must be admitted, that the process itself is not well calculated to attain the accuracy requisite in such an investigation; and in fact, that an accurate method for the determination of small quantities of nitrogen, or rather of nitric acid, is still a great desideratum.

We repeat, then, that for the reasons stated, we refrain from recording the numerical results yet obtained in regard to the amount of *nitric acid* in the waters examined; nor can we with full confidence rely even upon their general indications, in the discussion of the important questions, with a view to the elucidation of which this investigation was chiefly undertaken, and to which we still hope to recur on some future occasion. After these precautionary observations, however, we may mention, that if the indications of our nitric acid determinations may be trusted at all, it would appear that whilst the per-centage and actual amount of ammonia might be less in the rain of thunder-storms, and when there is a large fall of rain, the amount of nitric acid, on the other hand, is probably increased under the influence of storms. The results too would further lead to the conclusion, that the amount of nitrogen brought down by the rain in the form of *nitric acid*, was considerably greater than that so deposited in the form of *ammonia*. On this point again, but without relying confidently on the indication, it may still be interesting to observe, that with the very small amount of ammonia brought down in the rain of the winter and spring months of 1853–54, so far as they were examined, and which were succeeded by such an abundant harvest, the nitric acid results, taking them as they stand, show a much higher amount than usual in the months in question. It is true, that a study of our Meteorological Tables is sufficient to show that other and more obvious and measurable climatic conditions materially conduced to such a favourable result.

In conclusion, since there can be no doubt, that nitrates, applied as manures, greatly enhance the growth of plants by virtue of the nitrogen they contain, any amount of nitrogen brought down from the atmosphere, in the form of nitric acid, must be considered to have an important influence on vegetation.

Herring Fishery averages of Wick District.

Letter to John Cleghorn, Esq.

Office for the Fisheries,
Wick, 2nd July, 1855.

Sir,—As desired in your note of to-day, I beg to give you the Herring Fishery averages of Wick District for the seven years ending 1854, in juxtaposition with those for the seven years ending 1824 (the earliest year thus embraced being the first in which the records of this Office exhibit the number of boats employed).

In regard to the netting by which the averages of those periods respectively were obtained, I find that the average size of a boat's train in the years 1818–24 was about one-half of the average size of that in the years 1848–54.

As you are anxious to have this information with the least possible delay, it is fortunate that your paper on the "Fluctuations in the Herring Fisheries" had induced me, with the view of acquainting myself as thoroughly as possible with the history of the fishery of this important district, to make the necessary investigation and calculations previously.

I am, Sir, your most obedient Servant,
W. Russell.

Wick District Fishery Averages referred to.

Year.	Number of boats.	Average per boat.	Year.	Number of boats.	Average per boat.
		Crans.			Crans.
1818	482	136	1848	822	131
1819	609	133	1849	800	160
1820	604	148	1850	804	121
1821	595	123	1851	1000	130½
1822	595	91	1852	1020	91½
1823	555	123	1853	1002	134
1824	625	123½	1854	936	115

INDEX I.

TO

REPORTS ON THE STATE OF SCIENCE.

OBJECTS and Rules of the Association, xv.
Places and times of meeting, with names of officers from commencement, xviii.
Members of Council from commencement, xxi.
Treasurer's account, xxiii.
Officers and Council, xxiv.
Officers of Sectional Committees, xxv.
Corresponding Members, xxvi.
Report of Council to General Committee at Liverpool, xxvi.
Report of Kew Committee, xxvii.
Recommendations adopted by General Committee at Liverpool, involving grants of money, xlvi; application to Government or public institutions, xlvii; not involving grants of money, or application to Government, xlviii.
Applications for Reports, &c. xlviii.
Printing of Communications, xlix.
Synopsis of grants of money appropriated to scientific objects, xlix.
General statement of sums paid on account of grants for scientific purposes, l.
Extracts from resolutions of the General Committee, liv.
Arrangement of general meetings, liv.
Address by the Earl of Harrowby, lv.

Æther, density of, 353.
Armstrong (W. G.) on the application of water-pressure machinery, 417.

Birt (W. R.) on a luminous beam, 410.
Boguslawski (M.) on remarkable meteoric phænomena, 413.
Bulard (C.), observations of meteors made at Midhurst by, 410.

Challis (Rev. Prof.), drawings of different features of a portion of the moon's surface, comprising Plato, the Alps, the valley of the Alps, and Cassini, 415.
Chesney (Major-Gen.) on the construction and general use of efficient life-boats, 327.
Comet of 1843, radiation of heat from the, 354.
Crystals, transmission of heat through, 348.

Daubeny (Prof.), thirteenth report on the growth and vitality of seeds, 439.

Earthquake phænomena, third report on the facts of, 1.
Earthquakes, catalogue of recorded, from 1606 B.C. to A.D. 1850, 2; report of the committee on, 370.

Fasel (F. Vnt.), observations of luminous meteors, 412.
Food, on the equivalency of starch and sugar in, 421.

Gilbert (J. H.) on the equivalency of starch and sugar in food, 421.
Gladstone (J. H) on the influence of the solar radiations on the vital powers of plants growing under different atmospheric conditions, 373.

Heat, third report on the present state of our knowledge of radiant, 337; theoretical refraction of, 341; transmission of, through crystals, 348; analogies of transmission of light and, by

waves, 351; origin of the solar, 352; radiation of, from the zodiacal light and from the comet of 1843, 354.
Henslow (Prof.), thirteenth report on the growth and vitality of seeds, 439.

James (Major), proceedings respecting seismometers constructed under the superintendence of, 370.

Knoblauch (M.), on his researches on radiant heat, 342.

Lawes (J. B.) on the equivalency of starch and sugar in food, 421.
Life-boats, on the construction and general use of efficient, 327.
Light, analogies of transmission of, and heat by waves, 351; radiation of heat from the zodiacal, 354.
Lindley (Prof.), thirteenth report on the growth and vitality of seeds, 430.
Lowe (E. J.), luminous meteors observed in 1853–54, by, 406.

Magnetic observatories, on some of the results obtained at the British Colonial, 355.
Mallet (Robert), third report on the facts of earthquake phænomena, 1.
Mare Crisium and its shores, on the, 416.
Melloni (M.), his recent experiments on radiant heat, 350.
Meteors, on luminous, 386, 412; on those of August 1853, *ib.*; catalogue of, made at Observatory, Stone Vicarage, Aylesbury, 394; at St. Ives, 406; at Highfield House Observatory, *ib.*; at Midhurst, 410.
Midhurst, observations of meteors made at, 410.
Moon's surface, on the physical character of the, 415; drawings of different features of a portion of the, *ib.*

Phillips (Professor), second report on the physical character of the moon's surface, as compared with that of the earth, 415.
Plants, on the influence of solar radiation on, 373.
Portlock (Colonel), report on earthquakes, with their proceedings respecting seismometers constructed under the superintendence of Major James, 370.
Powell (Rev. Baden), third report on the present state of our knowledge of radiant heat, 337; seventh report on observations of luminous meteors, 1853–54, 386; letter to, from Mr. Birt, on a luminous beam, 410; letter to, from Mr. Fasel, on luminous meteors, 412.
Robinson (Rev. Dr.), second report on the physical character of the moon's surface, as compared with that of the earth, 415.
Rosse (the Earl of), second report on the physical character of the moon's surface, as compared with that of the earth, 415.

Sabine (Colonel Edward) on some of the results obtained at the British Colonial magnetic observatories, 355.
Seeds, on the growth and vitality of, 439.
Seismometers, on, 370.
Ships, on the deviations of the compass in wooden and iron, 434.
Smith (Archibald) on the deviation of the compass in wooden and iron ships, 434.
Smyth (Prof. C. Piazzi) on the "Mare Crisium and its shores," 416.
Solar radiation on plants, on the influence of, 373.
Starch and sugar in food, on the equivalency of, 421.

Thomson (Prof. W.) on solar heat, 352.

Water-pressure machinery, on the application of, 417.
Watts (J. King), catalogue of luminous meteors observed in 1853–54, at St. Ives, Hunts, 406.

Zodiacal light, radiation of heat from the, 354.

INDEX II.

TO

MISCELLANEOUS COMMUNICATIONS TO THE SECTIONS.

ACIDS: — physiological properties of carbazotic, 65; action of gallic and tannic, on iron and alumina mordants, *ib.*; action of citric, tartaric, and oxalic, on cotton and flax fibres, *ib.*; on a method of analysis applicable to the quantitative estimation of nitric and acetic, 68; on nitric, in rain-water, 70, 164; on the presence of lead in hydrochloric and nitric, 72; on the production of boracic, by volcanic action, 76.

Africa, on the occurrence of a true cretaceous formation in the south of, 83; on the arrival of Dr. Livingston at Loanda, on the west coast of, 119.

African dress, on the adornment of an, 99.

African languages, South, 126.

Air-engine, on the means of realizing the advantages of the, 159.

Albinoism, on a case of partial, in a black man, 110.

Albion mines in Nova Scotia, on the meteorology of the, 35; table of meteorological means for ten years at the, 44; climate of the, *ib.*; daily mean temperature for eleven years, 46.

Albumen, on photographs upon, 67.

Alcohol, on the concentration of, in Sömmering's experiments, 69.

Algæ, on the effect of coloured media on the growth of red, 77.

Alkalies, on the hyposulphites of the organic, 70.

Alkalimetry, on a new method of, 74.

Alkaloids, on the, produced during the destructive distillation of animal substances, 64.

Allen (Capt. W.) on levels taken in Jerusalem with the aneroid barometer, 116.

Allman (Prof.) on the occurrence in the infusoria of peculiar organs resembling thread-cells, 105.

Alumina mordants, on the action of gallic and tannic acids on, 65.

America, on the extension of the submarine telegraph to, 7; on telegraphic communication between England and, 147.

Ammonia, on the amounts of, and methods of estimating, in rain-water, 70, 164; on the production of, by volcanic action, 76.

Amyle, on the physiological properties of, 76.

Anderson (Dr.) on the alkaloids produced during the destructive distillation of animal substances, 64; on the constitution of meconine and papaverine, and their relations to the other constituents of opium, *ib.*

Anemometer at the Liverpool observatory, on the, 34.

Animal substances, on the alkaloids produced during the destructive distillation of, 64.

Animals, on drawings of various marine, 102.

Annelid tracks, on, 86.

Annulosa, on the vascular system of the lower, 109.

Ant-eater, on the anatomy of the great, 113.

Anthracite, on the deposits in the lower Silurians of the south of Scotland, 86; on the Silurian, of Cavan, 95.

Antiquities, notices of the Hoylake, 129.

Apes, on the anthropoid, 111.

Aquaria, observations made in small, 115.

Aquavivaria, on a plan of aërating, adopted by Dr. Ball, 115.

Archer (T. C.) on some peculiarities discovered in liquid caoutchouc, 96; on some materials for making paper, 97.

Architecture, naval, on the progress of, 160.

Arctic and antarctic currents, and their connexion with the fate of Sir John Franklin, 117.

Arctic regions, on glaciers in the, 126.

Arithmometer, on a new, 1.

Ashworth (Henry) on the causes and consequences of the Preston strike, 1853 to 1854, 130.

Asia, central, extracts from the MS. notes of travels of General Fevrier in, 125.
Asteroids, on, 19.
Astronomy, 19; meteoric, 26.
Atmopolarimeter, on a, 6.
Aulaga, on the lake, and its drainage in the desert of Caranjas, in Bolivia, 120.
Auroræ boreales seen at St. Ives, 47.
Australia, on the shortest routes to, 120; on the supply of gold from, 133.
Australian expedition, communications on an, 125.
Australian gold-fields, on the treatment of abandoned workings of the, 142.
Azores, on some points connected with the natural history of the, 108.

Babinet's homalographic maps, on, 2.
Babinet (M.) on a new photometer, 2.
Bache's tide observations, the Rev. W. Whewell on, 28.
Baker (T. B. Lloyd) on the reformation of offenders, 132.
Bakewell (Frederick) on telegraphic communication between England and America, 147.
Balfour (Dr.) on the occurrence in coal of peculiar vegetable organisms resembling the sporangia of Lycopodium, 97.
Ball (Dr.), on a plan of aërating aquavivaria adopted by, 115.
Bank notes, country, on the laws of the currency, as exemplified in the circulation of, in England, since the Act of 1844, 136.
Banks, joint stock, on the rise, progress, and present condition of, 138.
Barometer, on levels taken in Jerusalem with the aneroid, 116.
Bernard (Dr. Felix) on indices of the refraction of transparent media, included between two parallel faces, and on a portable refractometer, 2; on a photometer, 4; on polarimetry, *ib.*
Berry (George Robert) on collodion negatives, 64.
Bills of exchange, magnitude and fluctuation of the circulation of, 143.
Birds, on some traces of harmonious colours in, 101.
Blech (Dr.) on South African languages, 126.
Blundell (Dr. J. W. F.) on an Australian expedition, 125.
Bodies, on the density of various, when subjected to enormous pressing forces, 56; on the solidification of, under great pressure, 149.
Boiler explosions, on the prevention of, 149.
Bolivia, on the lake Aulaga, and its drainage in the desert of Caranjas, in, 120.
Botany, 96.
Boult (J.), diagrams illustrative of the changes in the bed of the river Mersey and its approaches, 117.
Brett (J. W.) on the origin of the submarine telegraph, and its extension to India and America, 7.
Bright (Edward B.) on magnetic electricity and underground wires, 8.
Britain, on the early ethnology of, 130.
British Association Catalogue of Stars, notes on the, 25.
British Meteorological Society, on photographic drawings of meteorological instruments adopted by the Council of the, 47.
Britons, on the forms of the crania of the ancient, 127.
Brodsworth, on the decomposition of magnesian limestone at, 66.
Brooke (C.) on an easy method of making thin glass cells for mounting microscopic objects in fluid, 47.
Bryson (A.) on a curious structure in the Silurian slates of Peebleshire, 78.
Buckman (Prof.) on two elephants' tusks found in the Stroud Valley, Gloucester, 78; on coal deposits in West Virginia, *ib.*
Buckton (G. Bowdler) on the application of cyanide of potassium to killing insects for the cabinet, 106.
Buxton (David) on the census of the deaf and dumb in 1851, 132.
Byerly (Isaac) on the fauna of Liverpool, 107.

Calculating machine, on a new, 1.
Calvert (Prof. F. C.) on the physiological properties of carbazotic acid, 65; on the action of gallic and tannic acids on iron and alumina mordants, *ib.*; on the action of citric, tartaric, and oxalic acids on cotton and flax fibres under the influence of dry heat and pressure of steam, 65.
Calvert (John) on the supply of gold from Australia and from English rocks, 133.
Caoutchouc, on some peculiarities discovered in liquid, 96.
Carpenter (P. P.) on land, fresh water, and marine shells obtained in sinking a well on the banks of the Avon, 78; list of four hundred and forty species of shells from Mazatlan, 107.
Carpenter (Dr. W. B.) on the development of the embryo of Purpura lapillus, 108.
Caucasus, on the, and parts of the Crimea, 124.

Cavan, on the Silurian anthracite of, 95.

Cayley (Arthur) on the solution of cubic and biquadratic equations, 1.

Cells, on the physiology of, 110.

Chacornac (M.)on solar spots and fæculæ, and their true causes, 19.

Chambers (Robert) on the great terrace of erosion in Scotland, and its relative date and connexion with glacial phænomena, 78; further observations on glacial phænomena in Scotland and the north of England, 79.

Chanter (John) on the œconomical working of steam boilers, 147.

Charcoal, on mineral, 86.

Charlesworth (Edward) on several new vertebrate fossils, 80.

Chemistry, 64.

Cheshire, statistics of poor relief and movement of population in the commercial district in the hundred of Wirral, 142.

Chimneys, on a lightning conductor for, 158.

Chronometers, on the variation in the rates of, 20.

Clare, on annelid tracks from the representatives of the millstone grits in the county of, 86.

Clay (Rev. John) on the effect of good and bad times on committals to prison, 133.

Clay (William) on the large fly-wheel erected at the Mersey Iron-works, Liverpool, 147; on a machine used for rolling taper iron, *ib.*

Cleghorn (John) on the fluctuations in the herring fisheries, 134, 176.

Climate of Southampton, on the, 29.

Coal, on the production of sulphurous acid gas from the combustion of, 75; on deposits of, in West Virginia, 78; on the occurrence in, of peculiar vegetable organisms resembling the sporangia of Lycopodium, 97; on the nature of the Torbane Hill and other varieties of, 102.

Coinage, on decimal, 135, 142; on the different plans which have been proposed of decimal accounts and, 143.

Collodion negatives, on, 64.

Colour, on associations of, and relations of colour and form in plants, 98; on some traces of harmonious, in plants, and the plumage of birds, 101.

Compass, on a graphic method of correcting the deviations of a ship's, 13; on the changes of the action of, in iron ships, 49; on the inefficiency of the aids of science at present in connexion with the, of iron ships, 55.

Copper, on the chemical examination of some alloys of, and zinc, 67.

Corn, on the current price and the cost price of, in England, during the last ten years, 134.

Cotton fibre, on the action of citric, tartaric, and oxalic acids on, 65.

Crania of the ancient Britons, on the forms of the, 127.

Craters, on the structure of lunar volcanic, 91.

Cretaceous formation, on the occurrence of a true, in the South of Africa, 82.

Crimea, on parts of the, 124.

Crosse (Andrew) on the apparently mechanical action accompanying electric transfer, 66.

Crystals, on measuring the absorption of polarized light in doubly refracting, 10; photogenic drawings of snow, seen in Jan. 1854, 30.

Crustacean impressions from the trias of Dumfries-shire, on, 86.

Cull (Richard) on the ethnological value of the results of philological inquiry, 126; description of three Esquimaux lately exhibited in London, *ib.*

Culley (Mr.) on the transmission of time-signals through the electric telegraph wires in connexion with the observatory at Greenwich, 148.

Cumming (Rev. J. G.) on some of the more recent changes in the area of the Irish Sea, 80.

Cunningham (John) on the submarine forest, Leasowe, 81; on ventilation of ships, 148; plan for reefing topsails, 150.

Currency, on the laws of the, 136; on a method of substituting francs and centimes for the present English metallic currency, 146.

Currents, on the heating effects of secondary, 68.

Danson (John Towne) on the current price and the cost price of corn in England during the last ten years, as illustrating the value of agricultural statistics, 134.

Davies (J. A.) on the decomposition of magnesian limestone at Brodsworth, 66.

Davis (Joseph Barnard) on the forms of the crania of the ancient Britons, 127.

Day (W.) on the œconomical working of steam-boilers and furnaces, by the saving of fuel, with a more speedy command of steam, 149.

Deaf and dumb, census of the, in 1851, 132.

De Colmar (M. T.) on a new arithmometer, or calculating machine, 1.

Dee and Mersey, on a geological section from the island of Little Eye across the peninsula between the estuaries of the, 86.

Diamagnetic force, on the, 14.

Dickie (Dr.) on associations of colour and relations of colour and form in plants, 98.

Dircks (H.) on the prevention of boiler explosions, 149.

Dock, on an iron floating graving, 163.

Dove (M.) on some stereoscopic phænomena, 9; on an apparatus for elliptically-polarized light, *ib.*; on a method of measuring the absorption of polarized light in doubly refracting crystals, 10; on the distribution of rain in the temperate zones, 28.

Drew (John) on the climate of Southampton, 29.

Duboscq (M.) on an apparatus for showing all the phænomena of light, 10.

Dumfries-shire, on crustacean impressions from the trias of, 86.

Earth, experiments on the movement of the, by means of the gyroscope, 56.

Ecuador, on the eastern territory of the, 123.

Edwards (Dr.) on collodion photographs of the moon's surface, 66.

Egerton (Sir Philip) on an ichthyoid fossil from India, 82.

Ehrenberg (Prof.) on the discovery of microscopic shells in the lower Silurian rocks, 82.

Eldridge (J.) on a new washing machine, 149.

Electric transfer, on the apparently mechanical action accompanying, 66.

Electrical battery, on a new, 75.

Electricity, 2.

Elephants' tusks found in the Stroud Valley, Gloucester, on, 78.

England, on the palæozoic system of, 95; on the current price and the cost price of corn in, during the last ten years, 131; on telegraphic communication between America and, 147.

Equations, on the solution of cubic and biquadratic, 1.

Erosion, on the great terrace of, in Scotland, and its relative date and connexion with glacial phænomena, 78.

Esquimaux, description of three, exhibited in London, 126.

Ethnological value of the results of philological inquiry, on the, 126.

Ethnology, 126; of the Liverpool district, 129; on the early, of Britain, 130.

Ethyle, on the physiological properties of, 76.

Etruscan question, notes on the, 126.

Eye, on pictorial and photochromatic impressions on the retina of the human, 12.

Fæculæ, on, 19.

Fairbairn (W.) on the density of various bodies when subjected to enormous compressing forces, 56; on the consumption of fuel and the prevention of smoke, 149; on the solidification of bodies under great pressure, *ib.*

Fauna of Liverpool, on the, 107.

Felis, on a supposed new species of, 113.

Fergusson (J.) on the site of the Holy Sepulchre at Jerusalem, 117.

Ferrière (M.) on photographs upon albumen, 67.

Fevrier (General), extract from the MS. notes of travels of, in Central Asia, 125.

Findlay (A. G.) on arctic and antarctic currents, and their connexion with the fate of Sir John Franklin, 117.

Firs, on the morphology of, 99.

Fisher's Venetian screw propeller, on, 151.

Fisheries, on the fluctuations in the herring, 134. 176.

Flax fibre, on the action of citric, tartaric and oxalic acids on, 65.

Fluids, on the motion of, 63.

Foliation, on the, of some metamorphic rocks in Scotland, 82.

Food, on the equivalency of starch and sugar in, 70.

Foraminifera, on the British species of, 113.

Forbes (David) on the chemical examination of some alloys of copper and zinc, 67; on the occurrence and chemical composition of some minerals from the south of Norway, *ib.*

Forbes (Prof. Edward) on the foliation of some metamorphic rocks in Scotland, 82; on some points connected with the Natural History of the Azores, 108.

Forest, submarine, of Leasowe, on the, 81.

Fossils, on several new vertebrate, 80; on ichthyoid, from India, 82.

Foucault (M. L.), nouvelles expériences sur le mouvement de la terre au moyen du gyroscope, 56.

Fowler (Dr.) on literary and philosophical pursuits as conducive to longevity, 114.

Franklin (Sir John), on arctic and antarctic currents, and their connexion with the fate of, 117.

Franklin (Jacob A.) on decimal coinage and accounts, showing the impracticability of the franc or tenpenny unit, 135.

Freund (Dr. W.) on the Etruscan question, 126.

Fuel, on the œconomical working of steam-boilers and furnaces, by saving of, 149; on the consumption of, *ib.*

Furnaces, on the œconomical working of, by the saving of fuel, 149.

Fusion of different substances, on the effect of pressure on the temperature of, 57.

Fly-wheel, on the large, lately erected at the Mersey Iron Works, 147.

Gabriel (Edmund), letter to Lord Clarendon on the arrival of Dr. Livingston at Loanda, 119.

Gale (Capt. S.) on the shortest routes to South Australia, 120.

Garden (Capt.) on the occurrence of a true cretaceous formation in the south of Africa, 83.

Gas, on the production of sulphurous acid, from the combustion of coal, 75.

Gassiot (J. P.) on the heating effects of secondary currents, 68.

Geography, 116.

Geology, 78; of India, 83.

Germany, on the palæozoic rocks of, 87.

Geysers of Iceland, on the cause of the phænomena exhibited by the, 73.

Gibson (Mr.) on a machine intended to prevent accidents in mines, 150.

Gilbart (J. W.) on the laws of the currency, as exemplified in the circulation of country bank notes in England since the passing of the act of 1844, 136.

Gilbert (Dr. J. H.) on the equivalency of starch and sugar in food, 70; on the amounts of, and methods of estimating, ammonia and nitric acid in rain water, 70, 164.

Glacial phænomena, on the great terrace of erosion in Scotland, and its relative date and connexion with, 78.

Glaciers, on the former probable existence of palæozoic, 93; on the thickness of the ice of the ancient, of N. Wales, 94; in the arctic regions, 126.

Gladstone (J. H.) on a method of analysis applicable to the quantitative estimation of nitric and acetic acids, 68; on the fluorescence exhibited by certain iron and platinum salts, *ib.*

Glaisher (James), photogenic drawings of snow crystals, as seen in Jan. 1854, 30.

Glass, on the influence of coloured, on the growth of plants in sea-water, 103.

Glass cells, on an easy method of making thin, for mounting microscopic objects in fluid, 17.

Gold, on the supply of, from Australia and from English rocks, 133; on the treatment of abandoned workings of the Australian gold fields, 142; exchangeable value of, in this country, if it has fallen below its former level, owing to the discoveries within the last six years, 143; on the influence of, on the progress and direction of British exports, 145.

Graham (Prof.) on the concentration of alcohol in Sömmering's experiments, 69.

Grantham (J.) on Cunningham's plan for reefing topsails, 150; on Fisher's Venetian screw propeller, 151; on a high-level railway for the Liverpool docks, *ib.*

Gray (Mr.) on vulcanized india-rubber springs to adjust the compass, to prevent the action of the needle being influenced by the motion of the ship, 151.

Greenough (G. B.) on the geology of India, 83.

Greg (Mr.) on meteorolites and asteroids, 19.

Grits, millstone, on annelid tracks from the representatives of the, in the county of Clare, 86.

Gunpowder, on the application of the voltaic battery to the ignition of, 18.

Gyroscope, sur le mouvement de la terre au moyen du, 56.

Hamilton (Sir W. R.) on an extension of quaternions, 1.

Hamilton (Dr.) on the lake Aulaga and its drainage in the desert of Caranjas, in Bolivia, 120.

Hamilton (G.) on the result of experiments on the preservation of fresh meat, 69.

Harkness (Prof.) on crustacean impressions from the trias of Dumfries-shire, 86; on annelid tracks from the representatives of the millstone grits in the county of Clare, *ib.*; on mineral charcoal, *ib.*; on the anthracite deposits and vegetable remains occurring in the lower Silurians of the south of Scotland, *ib.*

Hartnup (John) on the variation in the rates of chronometers, 20.
Hawkes (William) on the strength of iron after repeated meltings, 151.
Heat, 2; on mechanical antecedents of, 59.
Henderson (Andrew) on ocean steamers and clipper ships, 152.
Henslow (Prof.) on the adornment of an African dress, 99.
Herring fisheries, on the fluctuations in the, 134, 176.
Highley (Samuel) on the management of some difficult subjects in the application of photography to science, 69; on the means of applying photography to war purposes in the army and navy, 70.
Holy Sepulchre at Jerusalem, on the site of the, 117.
Hopkins (W.) on the effect of pressure on the temperature of fusion of different substances, 57.
How (Henry) on the hyposulphites of the organic alkalies, 70.
Hoylake antiquities, notices of the, 129.
Huggate, on the meteorology of, 34.
Hull (Edward) on a geological section, from the island of Little Eye across the peninsula between the estuaries of the Dee and Mersey to the east of Liverpool, 86.
Hume (Rev. Abraham) on the ethnology of the Liverpool district, with notices of the Hoylake antiquities, 129; on the education of the poor in Liverpool, 138.
Huxley (T. H.) on the vascular system of the lower annulosa, 109.
Hyposulphites, on the, of the organic alkalies, 70.

Iceland, on the cause of the phænomena exhibited by the geysers of, 73.
Ice of the ancient glaciers of North Wales, on the thickness of the, 94.
India, on the extension of the submarine telegraph to, 7; on an ichthyoid fossil from, 82; on the geology of, 83.
Infusoria, on the occurrence in the, of peculiar organs resembling thread-cells, 105.
Inman (Dr. T.) on the power by which insects are enabled to adhere to smooth perpendicular surfaces, 109; on a case of partial Albinoism in a black man, 110.
Insects, on the application of cyanide of potassium to killing, for the cabinet, 106; on the power by which they are enabled to adhere to smooth perpendicular surfaces, 109.
Instruments, microscopic and other, 47.
Iodine, on the distribution of, in the mineral, vegetable and animal kingdoms, 72.
Irish Sea, on some of the more recent changes in the area of the, 80.
Iron, on the action of gallic and tannic acids on mordants, 65; on the estimation of, by the method of Marguérite, 74; on the supposed influence of the hot-blast in augmenting the quantity of phosphorus in cast, ib.; on a machine used for rolling taper, 147; on the strength of, after repeated meltings, 151.
Israel, on the lost tribes of, 129.

Jacob (W. S.) on the British Association Catalogue of Stars, 25.
Jellicoe (Charles) on improving the present mode of keeping and stating the national accounts, 138.
Jerusalem, on levels taken in, with the aneroid barometer, 116; on the site of the Holy Sepulchre at, 117.
Jukes (J. B.) on the one-inch map of the northern part of the County Wicklow, geologically coloured, 87.

Kennedy (James) on the lost tribes of Israel, 129.
Keogh (Mr.) on a new kind of powerloom, 156.
Kisaludini, letter from the Rev. J. Rebmann to the Rev. H. Venn, from, 123.
Knight (James) on the rise, progress, and present condition of joint stock banks, 138.
Knight (G.) on a stereoscopic cosmoramic lens, designed by, 70.
Knipe (S.) on geological sections in the neighbourhood of Liverpool, 87.
Koh-i-noor diamond, on the recutting of the, 75.

Languages, on South African, 126.
Lankester (Dr.) on Wollaston's "Insects of the Madeira Islands," and "Melly's collection of Insects," 110.
Latham (Dr. R. G.) on the non-Russian populations of Russia in Europe, 129, 139.
Lawes (J. B.) on the equivalency of starch and sugar in food, 70; on the amounts of, and methods of estimating, ammonia and nitric acid in rain-water, 70, 164.
Lawson (G.) on the stipular glands of Rubiaceæ, 99.

Laycock (Dr.) on the physiology of cells in relation to consciousness and adaptive movements, 110.

Lead, on the presence of, in hydrochloric and nitric acids, 72.

Leaf-venation and ramification of the plant, on the correspondence between the, 100.

Leasowe, on the submarine forest of, 81.

Lee (Dr.) on photographic drawings of meteorological instruments adopted by the Council of the British Meteorological Society, 47.

Leech, on the medicinal, 113.

Lens, on a stereoscopic cosmoramic, 70.

Lenses, on a method of manufacturing cylindrical, 47.

Lewis (Rev. T. T.) on a slab of old red sandstone from Puddlestone, near Leominster, 91.

Light, 2; on an apparatus for elliptically-polarized, 9; on measuring the absorption of polarized, in doubly refracting crystals, 10; on an apparatus for showing all the phænomena of, *ib.*; on errors which may be occasioned by disregarding the influence of solar or artificial, on magnets, 12; on mechanical antecedents of, 59.

Lightning conductor for chimneys, on a, 158.

Lime, borate of, 75.

Limestone, on the decomposition of, at Brodsworth, 66; on carboniferous, at Llysfaen and Penmaen Rhos, near Abergele, 93; on fossil remains of fishes from the carboniferous, of Tortworth, 95.

Lindsay (J. B.) on some experiments upon a telegraph for communicating across rivers and seas, without employing a submerged cable, 157.

Liquids, on a method of computing the absolute volume of the ultimate particles of, 63.

Liverpool, on the deviation of the magnetic needle peculiar to, 12; on several sections in the neighbourhood of, 87; on recent additions to the muscology of, 102; on the fauna of, 107; hydrographical remarks on the improvement of the port of, 124; on the hazardous and uncertain approaches to the port of, 126; on the ethnology of the district of, 129; on the education of the poor in, 138; on a high level railway for the docks of, 151.

Livingston (Dr.), on the arrival of, at Loanda, on the west coast of Africa, 119; letter to the Rev. Arthur Tidman, from Sekeletu, Linyanti, 121.

Loanda, on the west coast of Africa, on the arrival of Dr. Livingston at, 119.

Longevity, on literary and philosophical pursuits as conducive to, 114.

Loom, on a new kind of power, 156.

Lunar surface, on micrometrical and photographic drawings of the, 25.

Lunar volcanic craters, on the structure of, 91.

Lycopodium, on the occurrence in coal of peculiar vegetable organisms resembling the sporangia of, 97.

Macadam (Stevenson) on the distribution of iodine in the mineral, vegetable and animal kingdoms, 72; on the presence of lead in hydrochloric and nitric acids, *ib.*; on the cause of the phænomena exhibited by the Geysers of Iceland, 73.

Magnetic field, on some peculiarities of the, 16.

Magnetic needle, on the deviation of the, peculiar to Liverpool, 12.

Magnetism, 2.

Magneto-electricity, and underground wires, on, 8.

Magnets, on errors which may be occasioned by disregarding the influence of solar or artificial light in, 12.

Maps, on Babinet's homalographic, 2.

Marratt (F. P.) on some new mosses, and on recent additions to the muscology of Liverpool, 102.

Masters (Maxwell T.) on the arrangement of the air-canals in the Nymphæaceæ (water-lilies), 102.

Mathematics, 1.

Mazatlan, on four hundred and forty species of shells from, 107.

M'Cosh (Rev. Prof.) on the morphology of pines and firs, 99; on the correspondence between the leaf-venation and ramification of the plant, 100; on some traces of harmonious colours in plants and the plumage of birds, 101.

McDermott (Mr.) on a new railway brake, 157.

McNerney (Mr.), statistics of poor relief and movement of population in the "commercial district" in the hundred of Wirral, Cheshire, 142.

Meat, on the results of experiments on the preservation of fresh, 69.

Mechanics, 147.

Meconine, on the constitution of, 64.

Media, on indices of the refraction of transparent, included between two parallel faces, 2.

Mersey, and its approaches, diagrams

illustrative of the changes in the bed of the, 117; on the estuary of the river, 126; on the large fly-wheel lately erected at the iron works, 147.
Meteoric astronomy, on, 26.
Meteorolites, on, 19.
Meteorological instruments, on photographic drawings of, adopted by the Council of the British Meteorological Society, 47.
Meteorology, 28; of Huggate, 34; of Nice Maritime for 1853, *ib.*; of the Albion Mines, Nova Scotia, 35.
Methyle, on the physiological properties of, 76.
Michel (H. E.) on the treatment of abandoned workings of the Australian gold fields, 214.
Microscopic objects in fluid, on an easy method of making thin glass cells for mounting, 47.
Milk, on the preservation of, 74.
Miller (William) on decimal coinage, 142; on the decimalization of the tariff, 143.
Minerals from the south of Norway, on the occurrence and chemical composition of some, 67.
Mines, on the meteorology of the Albion, in Nova Scotia, 35; on a machine intended to prevent accidents in, 150.
Moigno (Abbé) on a new arithmometer, 1; on Babinet's homalographic maps, 2; on the preservation of milk, 74.
Moon, on photographs of the, 10.
Moon's surface, on collodion photographs of the, 66.
Moore (Mr.) on rare animals in the Museum of Natural History in Liverpool, 111.
Mordants, on the action of gallic and tannic acids on iron and alumina, 65.
Mortar, marine, on destroying ships by means of a, 158.
Mosses, on some new, 102.
Motion, on mechanical antecedents of, 59.
Murchison (Sir R. I.) on the palæozoic rocks of Germany, 87; on a slab of old red sandstone from Puddlestone, near Leominster, 91.
Muscology of Liverpool, on recent additions to the, 102.

Napo, on the eastern territory of the Ecuador and the river, 123.
Nasmyth (James) on the structure of lunar volcanic craters, 91; on a method of boring holes in rock for tunnelling purposes, 157; on destroying ships by means of a marine mortar, 158; on a lightning conductor for chimneys, *ib.*
National accounts, suggestions for improving the present mode of keeping and stating the, 138.
Navigation, 49; on the progress of steam, 160.
Newmarch (William), magnitude and fluctuation of the circulation of bills of exchange, 1816 to 1853, 143; facts and statements connected with the question,—whether, in consequence of the discoveries within the last six years, the exchangeable value of gold in this country has fallen below its former level, 143.
Nevins (Dr. J. B.) on the storms which have visited England and Ireland during 1852, 1853, and 1854, with reference to the theory of rotatory storms, 30.
Nice Maritime, on the meteorology of, for 1853, 34; the statistics of, 145.
Nicholson (E. C.) on the estimation of iron by the method of Marguérite, and on the preparation of the standard solution of permanganate of potash, 74.
Nicolay (Rev. C. G.) on the eastern territory of the Ecuador and the river Napo, 123.
Norton (Capt. J.) on some railway signals, 158.
Norway, on the occurrence and chemical composition of some minerals from the south of, 67.
Nova Scotia, on the meteorology of the Albion mines in, 35.
Nymphæaceæ, on the arrangement of the air-canals in the, 102.

Offenders, on the reformation of, 132.
Opium, on the relation of meconine and papaverine to the other constituents of, 64.
Osler (F.) on his anemometer and rain-gauge at the Liverpool Observatory, 34.
Owen (Prof.) on the anthropoid apes, 111; on the anatomy of the great ant-eater, 113.

Page (D.) on the subdivision of the palæozoic rocks of Scotland, 91; on the structure and texture of stratified rocks, as a means of determining the conditions under which they are formed, 92.
Papaverine, on the constitution of, 64.
Paper, on some materials for making, 97.
Patterson (Robert) on Priapulus cau-

datus, 113; on living sea animals, *ib.*; on a plan of aërating aquavivaria adopted by Dr. Ball, 115.

Peach (Mr.) on specimens of old red sandstone from Gallows Hill, near Thurso, 92.

Peebleshire, on a curious structure in the Silurian slates of, 78.

Petrie (William) on the motion of fluids; a remarkable variation in the great elementary law of the ratio between pressure and velocity, 63.

Phillips (John) on micrometrical and photographic drawings of the lunar surface, 25.

Philological inquiry, on the ethnological value of the results of, 126.

Phosphorus, on the supposed influence of the hot-blast in augmenting the quantity of, in cast-iron, 74.

Photography:—on photographs of the moon and the sun, 10; on drawings of the lunar surface, 25; on drawings of meteorological instruments adopted by the Council of the British Meteorological Society, 47; of the moon's surface, on collodion, 66; upon albumen, 67; on the management of some difficult subjects in the application of, to science, 69; on the means of applying, to war purposes in the army and navy, 70; on the application of, to the delineation of microscopic objects, 116.

Photometer, on a, 2, 4.

Physics, 1, 56.

Pile, on the limit of weight which may safely be laid on a, driven into the ground, 163.

Pines, on the morphology of, 99.

Plants, on associations of colour, and relations of colour and form in, 98; on the correspondence between the leaf-venation and ramification of, 100; on some traces of harmonious colours in, 101; on the influence of coloured glass on the growth of, in sea-water, 103.

Polarimeter, on a, 6.

Polarimetry, on, 4.

Poole (H.) on the meteorology of the Albion Mines, Nova Scotia, 35.

Poor, on the education of the, in Liverpool, 138.

Population, statistics of poor relief, and movement of, in the "commercial district" in the hundred of Wirral, Cheshire, 142.

Potash, on the preparation of the standard solution of permanganate of, 74.

Potassium, on the application of cyanide of, to killing insects for the cabinet, 106.

Pressure, on the effect of, on the temperature of fusion of different substances, 37.

Preston strike in 1853 to 1854, on the causes and consequences of the, 130.

Priapulus caudatus, on, 113.

Price (Dr. A. P.) on a new method of alkalimetry, 74.

Price (David S.) on the estimation of iron by the method of Marguérite, and some notes on the preparation of the standard solution of permanganate of potash, 74; on the supposed influence of the hot-blast in augmenting the quantity of phosphorus in cast iron, *ib.*

Price (J.) on carboniferous limestone, at Llysfaen and Penmaen Rhos, near Abergele, 93.

Price (Rev. —), on drawings of various marine animals, 102.

Printing machine, on an improved, 163.

Prison, on the effect of good and bad times on committals to, 133.

Propeller, on Fisher's Venetian screw, 151.

Prosser (Mr.) on unchanged steam, 159.

Pumps, experiments to be made on centrifugal, 163.

Purpura lapillus, on the development of the embryo of, 108.

Quaternions, on an extension of, 1.

Railway, on a high level, for the Liverpool Docks, 151.

Railway-signals, on, 158.

Rain, on the distribution of, in the temperate zones, 28.

Rain-fall, on some simultaneous observations of, at different points on the same mountain range, 46.

Rain-gauge at the Liverpool Observatory, on the, 34.

Rain-water, on ammonia and nitric acid in, 70, 161.

Ramsay (Prof. A. C.) on the former probable existence of palæozoic glaciers, 93; on the thickness of the ice of the ancient glaciers of North Wales, and other points bearing on the glaciation of the country, 94.

Rankin (Rev. T.) on the meteorology of Huggate, 34.

Rankine (W. J. Macquorn) on some simultaneous observations of rain-fall at different points on the same mountain range, 46; on formulæ for the maximum pressure and latent heat of vapours,

58; on the means of realizing the advantages of the air-engine, 159.
Rathbone (Theodore W.) on the different plans which have been proposed of decimal accounts and coinage, 143.
Reade (Rev. J. B.) on photographs of the moon and of the sun, 10.
Rebmann (the Rev. J.), letter from, to the Rev. H. Venn, from Kisaludini (in Rabbai), 123.
Redfern (Dr.) on the nature of the Torbanehill and other varieties of coal, 102.
Refractometer, on a portable, 2.
Reid (Dr.) on the plan of ventilating St. George's Hall, 159.
Rennie (George), hydrographical remarks on the improvement of the port of Liverpool, 124.
Richardson (J.) on the medicinal leech, 113.
Rocks, on the foliation of some metamorphic, in Scotland, 82; on the discovery of microscopic shells in the lower Silurian, *ib.*; on the palæozoic, of Germany, 87; on the subdivisions of the palæozoic, of Scotland, 91; on the structure and texture of stratified, 92; on the supply of gold from English, 133; on a method of boring holes in, for tunneling purposes, 157.
Rope, on the origin of wire, 162.
Ross (Sir John) on the deviation of the magnetic needle peculiar to Liverpool, 12; on errors which may be occasioned by disregarding the influence of solar or artificial light in magnets, *ib.*
Rubiaceæ, on the stipular glands of, 99.
Russell (John Scott) on the progress of naval architecture and steam navigation, including a notice of the large ship of the Eastern Steam Navigation Company, 160.
Russell (W.), letter to J. Cleghorn on the herring fisheries of Wick district, 176.
Russia in Europe, on the non-Russian populations of, 129, 139.

Sailing, on modifications of great-circle, 126.
Salts, on the fluorescence exhibited by certain iron and platinum, 68.
Sandstone, on a slab of old red, from Puddlestone, near Leominster, 91; on specimens of old red, from Gallows Hill, near Thurso, 92; on fossil remains of fishes from the old red, of Herefordshire, 95; on the May Hill, *ib.*; on Zamites gigas from the, and shale of the Yorkshire coast, 103.
Saxby (Mr.) on mechanical appliances on board merchant ships, 161.
Scoresby (Rev. W.) on pictorial and photochromatic impressions on the retina of the human eye, 12; on the loss of the "Tayleur," and the changes in the action of compasses in iron ships, 49; an inquiry into the principles and measures on which safety in the navigation of iron ships may be reasonably looked for, 53, 161.
Scotland, on the great terrace of erosion in, 78; further observations on glacial phænomena in, and the north of England, 79; on the foliation of some metamorphic rocks in, 82; on the anthracite deposits and vegetable remains in the lower Silurians of the south of, 86; on the subdivisions of the palæozoic rocks of, 91.
Screw propeller, on Fisher's Venetian, 151.
Sea animals, on living, 113.
Sea-water, on the artificial preparation of, for marine vivaria, 77; on the influence of coloured glass on the growth of plants in, 103.
Sedgwick (Rev. Prof.) on the May Hill sandstone, and the palæozoic system of England, 95.
Sekeletu, letter from the Rev. Dr. Livingston from, 121.
Sewell (John) on steam-boiler explosions, 162.
Sewerage of manufacturing towns, on the, 77.
Seymour (D.) on the Caucasus and parts of the Crimea, 124; on the MS. notes of travels of General Fevrier in central Asia, 125.
Shells, land, freshwater and marine, obtained in sinking a well on the banks of the Avon, 78; on the discovery of microscopic, in the lower Silurian rocks, 82; on four hundred and forty species of, from Mazatlan, 107.
Ship's compass, on a graphic method of correcting the deviations of a, 13.
Ships, on the changes in the action of compasses in iron, 49; on the principles and measures on which safety in the navigation of iron, may be reasonably looked for, 53, 161; on the inefficiency of the aids of science at present in connexion with the compasses of iron, 55; on ventilation of, 148; on clipper, 152; on destroying, by means of a marine mortar, 158; on mechanical appliances on board merchant, 161.

Sims (Mr.) on borate of lime, 75.
Slates, Silurian, of Peeblesshire, on a curious structure in the, 78.
Smith (A.) on a graphic method of correcting the deviations of a ship's compass, 13; on the origin of wire-rope, its qualities and œconomy, 162.
Smoke, on the prevention of, 149.
Snow-crystals, photogenic drawings of, seen in Jan. 1854, 30.
Solar spots, on, 19.
Sömmering's experiments, on the concentration of alcohol in, 69.
Southampton, on the climate of, 29.
Spence (Joseph) on the production of sulphurous acid gas from the combustion of coal, 75.
Stangeria paradoxa, on, 104.
Starch, on the equivalency of, and sugar in food, 70.
Stars, notes on the British Association Catalogue of, 25.
Stather (J.) on an improved printing machine, 163.
Steam, on unchanged, 159.
Steamers, on ocean, 152.
Steam-boilers, on the œconomical working of, 147; on the œconomical working of, by the saving of fuel, with a more speedy command of steam, 149; on explosions of, 162.
Steam navigation, on the progress of, 160.
Stereoscopic cosmoramic lens, on a, 70.
Stereoscopic phænomena, on some, 9.
Stevelly (Prof.) on the limit of weight which may safely be laid on a pile driven into the ground, 163.
St. Georges' Hall, on the plan of ventilating, 160.
St. Ives, on auroræ boreales seen at, 47.
Storms which have visited England and Ireland during 1852, 1853, and 1854, on the, 30.
Sturm (Prof.) on a method of manufacturing cylindrical lenses, 47.
Sturt (Captain Charles) on an Australian expedition, 125.
Sugar, on the equivalency of starch and, in food, 70.
Sun, on photographs of the, 10.
Sutherland (Dr.) on glaciers in the arctic regions, 126.
Sykes (Colonel) on the meteorology of Nice Maritime for 1853, 34; statistics of Nice Maritime, 145.
Symonds (Rev. W.) on some fossil remains of fishes from the old red sandstone of Herefordshire and the carboniferous limestone of Tortworth, 95.
Symons (W.) on a new electrical battery, 75.

Tariff, on the decimalization of the, 143.
Tayleur, on the loss of the ship, 49.
Taylor (J.) on an iron floating graving dock, 163.
Telegraph, on the origin of the submarine, and its extension to India and America, 7; on improvements in submarine and subterranean, communication, 17; on communication between England and America, 147; on some experiments upon a, for communicating across rivers and seas, 157.
Telescopes, on natural occurrences that impair the vision of, 48.
Temperature of fusion of different substances, on the effect of pressure on, 57.
Tennant (Prof. J.) on the re-cutting of the Koh-i-noor diamond, 75.
Terre, sur le mouvement de la, au moyen du gyroscope, 56.
Thermo-electricity, experimental researches in, 13.
Thomson (Prof. W.), experimental researches in thermo-electricity, 13; on mechanical antecedents of motion, heat and light, 59.
Thornton (J.) on the friction of discs in water and on the experiments to be made on centrifugal pumps, 163.
Thread-cells, on the occurrence in the infusoria of peculiar organs resembling, 105.
Tide observations, on, 28.
Tidman (Rev. Arthur), letter from the Rev. Dr. Livingston, from Sekeletu, Linyanti, 121.
Time-signals, on the transmission of, through the electric telegraph wires in connexion with Greenwich Observatory, 148.
Topsails, on Cunningham's plan for reefing, 150.
Torbanehill coal, on the nature of the, 102.
Towson (J. T.) on the inefficiency of the aids of science at present in connexion with the compasses of iron ships, 55; on modifications of great-circle sailing, 126.
Trias of Dumfries-shire, on crustacean impressions from the, 86.
Turnbull (Dr. James) on the physiological properties of some of the compounds of the organic radicals—methyle, ethyle, and amyle, 76.
Tyndall (Professor) on the diamagnetic force, 14; on some peculiarities of the magnetic field, 16.

Valpy (R.), progress and direction of British exports, and the influence thereon of free trade and gold, 145.

Vapours, on formulæ for the maximum pressure and latent heat of, 58.

Varley (C. F.) on improvements in submarine and subterranean telegraph communication, 17.

Varley (Cornelius) on natural occurrences that impair the vision of good telescopes, 48.

Vaughan (Daniel) on meteoric astronomy, 26.

Vegetable remains in the lower Silurians of the south of Scotland, on the, 86.

Venn (the Rev. H.), letter from the Rev. J. Rebmann to, from Kisaludini, 123.

Virginia, West, on coal deposits in, 78.

Vivaria, marine, on the artificial preparation of sea-water for, 77.

Volcanic action, on the production of boracic acid and ammonia by, 76.

Voltaic battery, on the application of the, to the ignition of gunpowder, 18.

Wales, North, on the thickness of the ice of the ancient glaciers of, 94.

Ward (Capt.) on the application of the voltaic battery to the ignition of gunpowder, 18.

Warington (R.) on the production of boracic acid and ammonia by volcanic action, 76; on the effect of coloured media on the growth of red Algæ, 77; on the influence of coloured glass on the growth of plants in sea-water, 103; observations made in small aquaria, in which the balance between the animal and vegetable organisms was permanently maintained, 115.

Washing machine, on a new, 149.

Water, report of experiments on the friction of discs in, 163.

Water-lilies, on the arrangement of the air-canals in the, 102.

Watersten (J. J.) on a method of computing the absolute volume of the ultimate particles of liquids, 63.

Watts (J. King) on auroræ boreales observed at St. Ives, 47.

Wenham (F.) on the application of photography to the delineation of microscopic objects, 116.

Whewell (Rev. W.) on Mr. Superintendent Bache's tide observations, 28.

Whitty (Prof. J.), on the Silurian anthracite of Cavan, discovered by, 95.

Wicklow, on the one-inch map of the northern part of the county, geologically coloured, 87.

Widdrington (Capt.) on a supposed new species of Felis, 113.

Williamson (Prof. W. C.) on the restoration of Zamites gigas from the lower red sandstone and shale of the Yorkshire coast, 103; on the British species of Foraminifera, 113.

Wilson (Prof.) on a new arithmometer, 1; on Babinet's homalographic maps, 2.

Wilson (Dr. G.) on the artificial preparation of sea-water for marine vivaria, 77.

Wilson (G. S.) on an Australian expedition, 125.

Wire-rope, on the origin of, 162.

Wires, on magneto-electricity and underground, 8.

Wright (T.) on the early ethnology of Britain, 130; on some remains of an early people in the south-eastern corner of Yorkshire, 130.

Wrightson (Francis) on the sewerage of manufacturing towns, 77.

Yates (James) on Stangeria paradoxa, 104; on a method of substituting francs and centimes for the present English metallic currency, 146.

Yates (J. B.) on the estuary of the river Mersey, and the hazardous and uncertain approaches to the port of Liverpool, 126.

Yorkshire, on Zamites gigas from the lower sandstone and shale of the coast, 103; on some remains of an early people in the south-eastern corner of, 130; statistics, *ib.*

Zamites gigas from the lower sandstone and shale of the Yorkshire coast, on, 103.

Zinc, on the chemical examination of some alloys of copper and, 67.

Zones, on the distribution of rain in the temperate, 28.

Zoology, 105.

List of those Members of the British Association for the Advancement of Science to whom Copies of this Volume [for 1854] *are supplied gratuitously, in conformity with the Regulations adopted by the General Committee.* [*See pp.* xv. & xvi.]

HONORARY MEMBER.

HIS ROYAL HIGHNESS, PRINCE ALBERT OF SAXE-COBURG AND GOTHA.

LIFE MEMBERS.

Adair, Lt.-Col. Robert A. Shafto, F.R.S., M.P., 7 Audley Square, London.
Adam, Walter, M.D.
Adams, John Couch, M.A., D.C.L., F.R.S., F.R.A.S., Pembroke College, Cambridge.
Ainsworth, Thomas, The Flosh, Egremont, Cumberland.
Aldam, William, Frickley Hall near Doncaster.
Alexander, William Maxwell, Southbarr, Paisley.
Allecock, Samuel, Rushulme Place near Manchester.
Allen, William J. C., Secretary to the Royal Belfast Academical Institution; 8 Wellington Place, Belfast.
Allis, Thomas, Osbaldwick Hall, York.
Ambler, Henry, Watkinson Hall, Ovenden near Halifax.
Amery, John, F.S.A., Park House, Stourbridge.
Andrews, Thos., M.D., F.R.S., M.R.I.A., Vice-President of, and Professor of Chemistry in, Queen's College, Belfast.
Ansted, David Thomas, M.A., F.R.S., 17 Manchester Street, Manchester Square, London.
Appold, John George, F.R.S., 23 Wilson Street, Finsbury Square, London.
Armistead, John, Springfield Mount near Leeds.
Arthur, Rev. William, M.A., 26 Campden Grove, Kensington, London.
Ashton, Thomas, M.D., 71 Mosley Street, Manchester.
Ashworth, Edmund, Egerton Hall, Turton near Bolton.
Atkinson, Joseph B., Cotham, Bristol.
Auldjo, John, F.R.S., Noel House, Kensington.
Ayrton, W. S., F.S.A., Harehills, Leeds.

Babbage, Charles, M.A., F.R.S., 1 Dorset Street, Manchester Square, London.
Babington, Charles Cardale, M.A., F.R.S., (*Local Treasurer*), St. John's College, Cambridge.
Backhouse, John Church, Blackwell, Darlington.
Baddeley, Capt. Fred. H., R.E., Ceylon.
Bain, Richard, Gwennap near Truro.
Bainbridge, Robert Walton, Middleton House near Barnard Castle, Durham.
Baker, William, 63 Gloucester Place, Hyde Park, London.
Baldwin, the Hon. Robert, H.M. Attorney-General, Spadina, Co. York, Upper Canada.
Balfour, John Hutton, M.D., Professor of Botany in the University of Edinburgh, F.R.S.E., F.L.S.; 2 Bellevue Crescent, Edinburgh.
Ball, John, M.R.I.A., 85 Stephen's Green, Dublin.
Ball, William, Rydall, Ambleside, Westmoreland.
Barbour, Robert, Portland St., Manchester.
Barclay, Joseph Gurney, Walthamstow, Essex.
Barnes, Thomas, M.D., F.R.S.E., Carlisle.
Barnett, Richard, 2 Avon Place, Emscote, Warwickshire.
Barton, John, Bank of Ireland, Dublin.
Bashforth, Francis, M.A., St. John's College, Cambridge.
Bateman, Joseph, LL.D., F.R.A.S., Startforth Hall, Barnard Castle.
Bayldon, John, Lendal, York.
Bayley, George, The Terrace, Camberwell, London.
Beamish, Richard, F.R.S.
Beatson, William, Rotherham.
Belcher, Capt. Sir Edw., R.N., F.R.A.S., 22 Thurloe Square, Brompton, London.
Belcombe, Henry Stephens, M.D., Minster Yard, York.
Bennoch, Francis, Blackheath Park, Kent.
Bergin, Thomas Francis, M.R.I.A., 49 Westland Row, Dublin.

[It is requested that any inaccuracy in the Names and Residences of the Members may be communicated to Messrs. Taylor and Francis, Printers, Red Lion Court, Fleet Street, London.]

Berryman, William Richard, 6 Tamar Terrace, Stoke, Devonport.
Bickerdike, Rev. John, M.A., Leeds.
Binyon, Alfred, Mayfield, Manchester.
Binyon, Thomas, St. Ann's Square, Manchester.
Bird, William, 9 South Castle Street, Liverpool.
Birks, Rev. Thomas Rawson, Kelshall Rectory, Royston.
Birley, Richard, Upper Brook Street, Manchester.
Birt, W. R., 11 Wellington Street, Victoria Park, London.
Blackwall, John, F.L.S., Oakland, Llanrwst, Denbighshire.
Blackwell, Thomas Evans, F.G.S., The Grove, Clifton, Bristol.
Blake, Hen. Wollaston, F.R.S., 8 Lowndes Street, Belgrave Square, London.
Blake, William, Bishop's Hull, Taunton.
Blakiston, Peyton, M.D., F.R.S., St. Leonard's-on-Sea.
Bland, Rev. Miles, D.D., F.R.S., 5 Royal Crescent, Ramsgate.
Boddington, Benjamin, Burcher, Kington, Herefordshire.
Bodley, Thomas, F.G.S., Anlaby House, Pittville, Cheltenham.
Boileau, Sir John Peter, Bart., F.R.S., 20 Upper Brook Street, London.
Bond, Walter M., The Argory, Moy, Ireland.
Boughton, Sir William Edward Rouse, Bart., F.R.S., Downton Hall near Ludlow, Shropshire.
Bowerbank, James Scott, F.R.S., 3 Highbury Grove, London.
Brady, Antonio, Maryland Point, Essex.
Brakenridge, John, Bretton Lodge, Wakefield.
Brammall, Jonathan, Sheffield.
Brett, John Watkins, 2 Hanover Square, London.
Briggs, Major-Gen. John, E.I.C.S., F.R.S.
Brisbane, General Sir Thos. Makdougall, Bart., K.C.B., G.C.H., D.C.L., Pres. of the Royal Society of Edinb., F.R.S.; Brisbane, Greenock.
Brogden, John, jun., F.G.S., Ulverstone, Lancashire.
Brooke, Charles, M.B., F.R.S., 29 Keppel Street, Russell Square, London.
Brooks, Samuel, Market Street, Manchester.
Brooks, Thomas, (Messrs. Butterworth and Brooks,) Manchester.
Broun, John Allan, F.R.S., Observatory, Trevandrum, India.
Brown, Thomas, Ebbw Vale Iron Works, Abergavenny.
Brown, William, Docks, Sunderland.
Bruce, Alexander John, Kilmarnock.
Bruce, Haliday, M.R.I.A., 37 Dame Street, Dublin.
Brunel, Isambart Kingdom, F.R.S., 18 Duke Street, Westminster.
Buck, George Watson, Ramsay, Isle of Man.
Buckland, Very Rev. William, D.D., Dean of Westminster, F.R.S.; The Deanery, Westminster.
Buckman, James, F.G.S., Professor of Botany, Royal Agricultural College, Cirencester.
Buckton, G. Bowdler, 38 Gloucester Place, Hyde Park Gardens, London.
Budd, James Palmer, Ystalyfera Iron Works, Swansea.
Buller, Sir Antony, Pound near Tavistock, Devon.
Bulman, John, Newcastle-upon-Tyne.
Burd, John, jun., Mount Sion, Radcliffe, Manchester.
Burlington, William, Earl of, M.A., LL.D., F.R.S., Chancellor of the University of London; 10 Belgrave Square, London.
Busk, George, F.R.S., Gloucester Crescent, Greenwich.

Campbell, Sir James, Glasgow.
Campbell, William, 34 Candlerigg Street, Glasgow.
Carew, William Henry Pole, Antony House near Devonport.
Carne, Joseph, F.R.S., Penzance.
Carpenter, Philip Pearsall, B.A., Academy Place, Warrington.
Carr, William, Blackheath.
Cartmell, Rev. James, B.D., F.G.S., Christ's College, Cambridge.
Cassels, Rev. Andrew, M.A., Batley Vicarage near Leeds.
Cathcart, Lieut.-General Charles Murray, Earl of, K.C.B., F.R.S.E., United Service Club, London.
Cayley, Sir George, Bart., Brompton, Yorkshire.
Challis, Rev. James, M.A., F.R.S., Plumian Professor of Astronomy in the University of Cambridge; Observatory, Cambridge.
Chambers, Robert, F.R.S.E., F.G.S., Edinburgh.
Champney, Henry Nelson, St. Paul's Square, York.
Chanter, John, 2 Arnold Terrace, Bow Road, Bromley.
Chatterton, Sir William, Bart., F.R.G.S., Castlemahon, Cork.
Cheetham, David, Staleybridge, Manchester.

Chesney, Major-General Francis Rawdon, R.A., D.C.L., F.R.S., Ballyardle, Kilkeel, Co. Down, Ireland.

Chevallier, Rev. Temple, B.D., F.R.A.S., Professor of Mathematics and Astronomy in the University of Durham; Durham.

Chichester, Ashhurst Turner Gilbert, D.D., Lord Bishop of, 43 Queen Ann Street, Cavendish Square, London.

Chiswell, Thomas, 19 Plymouth Grove, Manchester.

Christie, Samuel Hunter, M.A., F.R.S.

Clark, Rev. Charles, M.A., Queen's College, Cambridge.

Clark, Francis.

Clark, Henry, M.D., 74 Marland Place, Southampton.

Clay, Joseph Travis, F.G.S., Rastrick near Huddersfield.

Coathupe, Charles Thornton, 3 Park Row, Bristol.

Cobbold, John Chevallier, M.P., Tower Street, Ipswich.

Cocker, Jonathan, Higher Broughton, Manchester.

Colfox, William, B.A., Bridport, Dorsetshire.

Compton, Lord Alwyne, Castle Ashby, Northamptonshire.

Compton, Lord William, 145 Piccadilly, London.

Consterdine, James, New Cannon Street, Manchester.

Conway, Charles, Pontnwydd Works, Newport, Monmouthshire.

Conybeare, Very Rev. William Daniel, Dean of Llandaff, M.A., F.R.S.; The Deanery, Llandaff.

Cooke, Arthur B., 6 Berkeley Place, Connaught Square, London.

Cooke, William Fothergill, Kidbrooke near Blackheath.

Corbet, Richard, Adderley, Market Drayton, Shropshire.

Cork, Cloyne and Ross, James Wilson, D.D., Lord Bishop of, M.R.I.A., Cork.

Cotton, Alexander, Landwade, Cambridgeshire.

Cotton, Rev. William Charles, M.A., New Zealand.

Courtney, Henry, M.R.I.A., 24 Fitzwilliam Place, Dublin.

Cox, Joseph, F.G.S., Wisbeach, Cambridgeshire.

Crampton, The Honourable Justice, LL.D., M.R.I.A., 3 Kildare Place, Dublin.

Crewdson, Thomas D., Dacca Mills, Manchester.

Crichton, William, 1 West India Street, Glasgow.

Crompton, Rev. Joseph, Norwich.

Crooke, G. W., Liverpool.

Currer, Rev. Danson Richardson, Clifton House, York.

Curtis, John Wright, Alton, Hants.

Cuthbert, J. R., 73 Mount Pleasant, Liverpool.

Dalby, Rev. William, M.A., Rector of Compton Basset near Calne, Wilts.

Dalton, Rev. James Edward, B.D., Seagrave, Loughborough.

Danson, Joseph, 6 Shaw Street, Liverpool.

Darbishire, Samuel D., Pendyffryn near Conway.

Daubeny, Charles Giles Bridle, M.D., F.R.S., Regius Professor of Botany, and Aldrich's Professor of Chemistry, in the University of Oxford; Oxford.

Dawbarn, William, Wisbeach.

Dawes, Rev. William Rutter, F.R.A.S., Wateringbury near Maidstone, Kent.

Dawson, Christopher H., Low Moor, Bradford, Yorkshire.

Dawson, Henry, 14 St. James's Road, Liverpool.

Deane, Sir Thomas, Dundanion Castle, Cork.

De la Rue, Warren, F.R.S., 7 St. Mary's Road, Canonbury Park, London.

Dent, Joseph, Ribston Hall, Wetherby, York.

Dickinson, Joseph, M.D., F.R.S., Liverpool.

Dikes, William Hey, F.G.S., Wakefield.

Dilke, C. Wentworth, F.G.S., 76 Sloane Street, London.

Dobbin, Leonard, jun., M.R.I.A., 27 Gardiner's Place, Dublin.

Dodsworth, Benjamin, St. Leonard's Place, York.

Dodsworth, George, Fulford near York.

Donaldson, John, Professor of the Theory of Music in the University of Edinburgh; Edinburgh.

Donkin, Thomas, F.R.A.S., Westow, Whitwell near York.

Dowden, Richard, Sunday's Well, Cork.

Drury, William, M.D., Claremont Buildings, Shrewsbury.

Duncan, James, M.D., Farnham House, Finglass, Co. Dublin.

Dunlop, William Henry, Annan Hill, Kilmarnock.

Dunraven, Edwin, Earl of, F.R.S., 3 Halkin Street West, London; and Adare, Co. Limerick.

Earnshaw, Rev. Samuel, M.A., Sheffield.

Edmondston, Rev. John, Selkirk.

Egerton, Sir Philip de Malpas Grey, Bart., M.P., F.R.S., Oulton Park, Cheshire.

Ellis, Rev. Robert, A.M., Grimstone House near Malton, Yorkshire.
Ellis, Thomas Flower, M.A., F.R.S., Attorney-General of the Duchy of Lancaster; 15 Bedford Place, London.
Enys, John Samuel, F.G.S., Enys, Cornwall.
Erle, Rev. Christopher, M.A., F.G.S., Hardwick Rectory near Aylesbury.
Evans, George Fabian, M.D., Waterloo Street, Birmingham.
Eyre, George Edward, F.G.S., Warrens near Lyndhurst, Hants.

Fairbairn, William, C.E., F.R.S., Manchester.
Faraday, Michael, D.C.L., F.R.S., Fullerian Professor of Chemistry in the Royal Institution of Great Britain; 21 Albemarle Street, London.
Farren, Edwin James, V.P.I.A., Hanover Chambers, Buckingham Street, Strand, London.
Fellows, Sir Charles, F.R.G.S., 4 Montagu Place, Russell Square, London.
Fischer, William L. F., M.A., Professor of Natural Philosophy in the University of St. Andrew's, Scotland.
Fisher, Rev. Thomas, M.A., Luccombe near Minehead, Somerset.
Fitzwilliam, Charles William, Earl, F.R.S., President of the Yorkshire Philosophical Society; Mortimer House, Halkin Street, Grosvenor Place, London.
Fleming, Colonel James, Kinlochlaich, Appin, Argyleshire.
Fleming, William M., Barochan, Renfrewshire.
Fleming, William, M.D., Manchester.
Fletcher, Samuel, Ardwick Place, Manchester.
Forbes, David, 34 Parliament Street, Liverpool.
Forbes, James David, LL.D., Professor of Natural Philosophy in the University of Edinburgh, Sec. R.S.E., F.R.S.; Edinburgh.
Forbes, Sir John, M.D., F.R.S., 12 Old Burlington Street, London.
Forrest, William Hutton, Stirling.
Forster, Thomas Emerson, 7 Ellison Place, Newcastle-upon-Tyne.
Forster, William, Ballynure, Clones, Ireland.
Fort, Richard (High Sheriff of Lancashire), Read Hall, Whalley, Lancashire.
Fortescue, Hugh, Earl, K.P., F.R.S., 17 Grosvenor Square, London.
Foster, Charles Finch, Mill Lane, Cambridge.
Foster, H. S., Cambridge.
Foster, John, M.A., Clapham, London.
Fowler, Robert, 23 Rutland Sq., Dublin.
Fox, Charles, Perran Arworthal near Truro.
Fox, Joseph Hayland, Wellington, Somerset.
Fox, Robert Barclay, Falmouth.
Fox, Samuel Lindoe, Tottenham.
Frankland, Rev. Marmaduke Charles, Chowbent near Manchester.
Freeland, Humphrey William, F.G.S., B 3 Albany, London.
Fullarton, Allan, Greenock.

Gadesden, Augustus William, F.S.A., Leigh House, Lower Tooting, Surrey.
Gaskell, Samuel, 19 Whitehall Place, London.
Gibson, George Stacey, Saffron Walden.
Gilbart, James William., F.R.S., London and Westminster Bank, Lothbury, London.
Gladstone, George, F.C.S., Stockwell Lodge, Stockwell, London.
Gladstone, John Hall, Ph.D., F.R.S., 21 Tavistock Square, London.
Goodman, John, M.D., The Promenade, Southport.
Goodsir, John, F.R.S. L. & E., Professor of Anatomy in the University of Edinburgh.
Gordon, James, 46 Park Street, Bristol.
Gordon, Rev. James Crawford, M.A., Delamont, Downpatrick, Downshire.
Gotch, Rev. Frederick William, B.A., 1 Cave Street, Bristol.
Gotch, Thomas Henry, Kettering.
Græme, James.
Graham, Thomas, M.A., F.R.S., Master of the Royal Mint, London.
Grainger, John, Rose Villa, Belfast.
Grattan, Joseph, 94 Shoreditch, London.
Graves, Rev. Charles, D.D., Professor of Mathematics in the University of Dublin, M.R.I.A.; 2 Trinity College, Dublin.
Graves, Rev. Richard Hastings, D.D., Brigown Glebe, Michelstown, Co. Cork.
Gray, Rev. David, M.A., F.R.S.E., Professor of Natural History in the Marischal College and University, Aberdeen.
Gray, John, Greenock.
Gray, John Edward, Ph.D., F.R.S., Keeper of the Zoological Collections of the British Museum; British Museum.
Gray, William, F.G.S., (*Local Treasurer*), Minster Yard, York.
Grazebrook, Henry, jun., 61 Canning Street, Liverpool.

Greenaway, Edward, 9 River Terrace, City Road, London.
Greswell, Rev. Richard, B.D., F.R.S., Beaumont Street, Oxford.
Griffin, John Joseph, Glasgow.
Griffith, Richard, M.R.I.A., F.G.S., Fitzwilliam Place, Dublin.
Griffiths, S. Y., Oxford.
Guinness, Rev. William Smyth, M.A., Rathdrum, Co. Wicklow.
Gutch, John James, 88 Micklegate, York.

Hall, T. B., Coggeshall, Essex.
Hallam, Henry, M.A., D.C.L., F.R.S., Trust. Brit. Mus., 24 Wilton Crescent, Knightsbridge, London.
Hamilton, Mathie, M.D., Warwick Street, Glasgow.
Hamilton, Sir William Rowan, LL.D., Astronomer Royal of Ireland, and Andrews' Professor of Astronomy in the University of Dublin, M.R.I.A., F.R.A.S.; Observatory near Dublin.
Hamilton, William John, Pres. G.S., 23 Chesham Place, Belgrave Square, London.
Hamlin, Captain Thomas, Greenock.
Harcourt, Rev. William V. Vernon, M.A., F.R.S., Bolton Percy, Tadcaster.
Hare, Charles John, M.D., 9 Langham Place, London.
Harley, John, Ross Hall near Shrewsbury.
Harris, Alfred.
Harris, George William, 17 Park Street, Westminster.
Harris, Henry, Heaton Hall near Bradford.
Harrison, William, Galligreaves House near Blackburn.
Harter, William, Hope Hall, Manchester.
Hartley, Jesse, Trentham Street, Liverpool.
Harvey, Joseph Chas., Youghal, Co. Cork.
Hatton, James, Richmond House, Higher Broughton, Manchester.
Haughton, William, 28 City Quay, Dublin.
Hawkins, John Isaac, C.E.
Hawkins, Thomas, F.G.S., 15 Great Ormond Street, London.
Hawkshaw, John, F.G.S., 23 Great George Street, Westminster.
Hawthorn, Robert, C.E., Newcastle-upon-Tyne.
Henry, Alexander, Portland Street, Manchester.
Henry, William Charles, M.D., F.R.S., Haffield near Ledbury, Herefordshire.
Henslow, Rev. John Stevens, M.A., F.L.S., Professor of Botany in the University of Cambridge, and Examiner in Botany in the University of London; Hitcham, Bildeston, Suffolk.
Herbert, Thomas, Nottingham.
Heywood, Sir Benjamin, Bart., F.R.S., 9 Hyde Park Gardens, London.
Heywood, James, M.P., F.R.S., 5 Eaton Place, London.
Heywood, Robert, Bolton.
Higgin, Edward, Liverpool.
Higson, Peter, Irwill Terrace, Lower Broughton, Manchester.
Hill, Rev. Edward, M.A., F.G.S., Sheering Rectory, Harlow.
Hill, Henry, Athenæum Club, Pall Mall, London.
Hill, Rowland, F.R.A.S., General Post Office, London.
Hindmarsh, Frederick, F.G.S., 17 Bucklersbury, London.
Hindmarsh, Luke, Alnwick, Northumberland.
Hoare, Rev. George Tooker.
Hoblyn, Thomas, F.R.S., White Barnes, Buntingford, Herts.
Hodgkin, Thomas, M.D., F.R.G.S., 35 Bedford Square, London.
Hodgkinson, Eaton, F.R.S., Professor of the Mechanical Principles of Engineering in University College, London; 44 Drayton Grove, Brompton, London.
Hodgson, Adam, Everton, Liverpool.
Holden, Moses, 13 Jordan Street, Preston.
Holditch, Rev. Hamnet, M.A., Caius College, Cambridge.
Holland, P. H., Poplar Cottage, 12 Brixton Villas, Brixton, London.
Hollingsworth, John, 10 Burney Street, Greenwich.
Hone, Nathaniel, M.R.D.S., 1 Fitzwilliam Square East, Dublin.
Hopkins, William, M.A., F.R.S., Cambridge.
Horner, Leonard, F.R.S., 17 Queen's Road West, Regent's Park, London.
Horsfield, George, Brampton Grove, Smedley Lane, Cheetham, Manchester.
Houldsworth, Henry, Newton Street, Manchester.
Hoyle, John, Brown Street, Manchester.
Hudson, Henry, M.D., M.R.I.A., 23 Stephen's Green, Dublin.
Hull, William Darley, F.G.S., 49 Milner Square, Islington, London.
Hulse, Edward, D.C.L., All Souls' College, Oxford.
Hutchison, Graham, 16 Blythswood Square, Glasgow.
Hutton, Robert, M.R.I.A., F.G.S., Putney Park, Surrey.
Hutton, William, North Terrace, West Hartlepool.

Ibbetson, Captain Levett Landen Boscawen, K.R.E., F.R.S., Clifton House, Old Brompton, London.
Inman, Thomas, M.D., Rodney Street, Liverpool.

Jackson, James Eyre, Tullydory, Blackwater Town, Armagh.
Jackson, Stephen, Butter Market, Ipswich.
Jacob, John, M.D., Maryborough.
Jardine, Sir William, Bart., F.R.S.E., Jardine Hall, Applegarth, by Lockerby, Dumfriesshire.
Jarratt, Rev. John, M.A., North Cave near Brough, Yorkshire.
Jee, Alfred S., 6 John Street, Adelphi, London.
Jenkyns, Rev. Henry, D.D., Professor of Divinity and Ecclesiastical History in the University of Durham; Durham.
Jenyns, Rev. Leonard, M.A., F.L.S., Swainswick near Bath.
Jerram, Rev. S. John, M.A., Witney, Oxfordshire.
Jerrard, George Birch, B.A., Examiner in Mathematics and Natural Philosophy in the University of London; Long Stratton, Norfolk.
Johnson, Thomas, Mosley Street, Manchester.
Johnston, James F. W., M.A., F.R.S., Professor of Chemistry in the University of Durham; Durham.
Johnstone, James, Alva near Alloa, Stirlingshire.
Johnstone, Sir John Vanden Bempde, Bart., M.P., M.A., F.G.S., 27 Grosvenor Square, London.
Jones, Christopher Hird, 2 Castle Street, Liverpool.
Jones, Major Edward, 5 York Place, Clifton, Bristol.
Jones, Josiah, 2 Castle Street, Liverpool.
Jones, Robert, 2 Castle Street, Liverpool.
Jones, R. L., Great George Square, Liverpool.
Joule, Benjamin, jun., New Bailey Street, Salford, Manchester.
Joule, James Prescott, F.R.S., Oakfield, Moss-side near Manchester.
Joy, Charles Ashfield, 45 Gloucester Road, Regent's Park, London.
Jubb, Abraham, Halifax.

Kay, John Robinson, Boss Lane House, Bury, Lancashire.
Kay, Rev. William, M.A., Lincoln College, Oxford.
Kelsall, Henry, Rochdale, Lancashire.
Kerr, Archibald, Glasgow.
Knowles, Edward R. J., 23 George Street, Ryde, Isle of Wight.
Knowles, William, Newport, Monmouthshire.
Knox, G. James, 2 Finchley New Road, St. John's Wood, London.

Lacy, Henry C., jun.
Laming, Richard, Millwall, London.
Langton, William, Manchester.
Lansdowne, Henry, Marquis of, K.G., D.C.L., F.R.S., Trust. Brit. Mus., 54 Berkeley Square, London.
Larcom, Colonel Thomas A., R.E., F.R.S., Chief Secretary's Office, Dublin Castle, Dublin.
La Touche, David Charles, M.R.I.A., Castle Street, Dublin.
Laurie, James, Langholm near Carlisle.
Leatham, Charles Albert, Wakefield.
Leatham, Edward Aldam, Wakefield.
Leather, John Towlerton, Leventhorpe Hall near Leeds.
Lee, John, LL.D., F.R.S., 5 College, Doctors' Commons, London.
Lee, John Edward, Caerleon, Monmouthshire.
Leese, Joseph, jun., Glenfield, Altrincham.
Leeson, Henry B., M.A., M.D., F.R.S., The Maples, Bonchurch, Isle of Wight.
Lefroy, Captain John Henry, R.A., F.R.S., Woolwich.
Legh, George Cornwall, M.P., F.G.S., High Legh, Cheshire.
Leinster, Augustus Frederick, Duke of, M.R.I.A., 6 Carlton House Terrace, London.
Le Mesurier, R. Arthur, M.A., Corpus Christi College, Oxford.
Lemon, Sir Charles, Bart., M.P., F.R.S., 46 Charles Street, Berkeley Square, London.
Lemon, James, jun., Ardville, Belfast.
Lindsay, Henry L., C.E.
Lingard, John R., F.G.S., Stockport, Cheshire.
Lister, Joseph Jackson, F.R.S., Upton, Essex.
Lloyd, George, M.D., F.G.S., Stank Hill near Warwick.
Lloyd, Rev. Humphrey, D.D., F.R.S., Vice-President of the Royal Irish Academy; 17 Fitzwilliam Square, Dublin.
Lloyd, George Whitelocke.
Lloyd, John Buck (Mayor of Liverpool), Liverpool.
Lobley, James Logan, 87 Brunswick Road, Liverpool.
Locke, John, Rathmines, Dublin.
Lockey, Rev. Francis, Swainswick near Bath.

Loftus, William Kennett, F.G.S.

Logan, William Edmond, F.R.S., Director of the Geological Survey of Canada; Montreal.

Londesborough, Albert Denison, Lord, K.C.H., F.R.S., 8 Carlton House Terrace, London; and Grimstone Park, Tadcaster, Yorkshire.

Lubbock, Sir John William, Bart., M.A., F.R.S., Mansion House Street, London.

Lubbock, John, 11 Mansion House Street, City, London.

Lucas, William, The Mills near Sheffield.

Luckcock, Howard, Oak Hill, Edgbaston, Birmingham.

Lundie, Cornelius, Tumnahulla, Headford, Ireland.

Lutwidge, Charles, M.A.

Lyell, Sir Charles, M.A., LL.D., F.R.S., V.P.G.S., 11 Harley Street, Cavendish Square, London.

Macadam, Stevenson, Ph.D., Surgeons' Hall, Edinburgh.

McAll, Rev. Edward, Rector of Brighstone, Newport, Isle of Wight.

McAndrew, Robert, F.R.S., (*Local Treasurer*), 84 Upper Parliament Street, Liverpool.

MacBrayne, Robert, Barony Glebe, Glasgow.

McConnel, James, Manchester.

Macrory, Adam John, Duncairn, Belfast.

McCulloch, George, M.D., Cincinnati, United States.

MacDonnell, Rev. Richard, D.D., Provost of Trinity College, Dublin, M.R.I.A.; Dublin.

McEwan, John, Glasgow.

Macfie, R. A., 72 Upper Parliament Street, Liverpool.

McGee, William, M.D., 10 Donegall Square East, Belfast.

MacIver, Charles, Abercromby Square, Liverpool.

Malcolm, Frederick, 4 Sion College, London Wall, London.

Mallet, Robert, F.R.S., M.R.I.A., 98 Capel Street, Dublin.

Manchester, James Prince Lee, D.D., Lord Bishop of, F.R.S., Sedgley near Manchester.

Marshall, James Garth, M.A., F.G.S., Headingley near Leeds.

Martineau, Rev. James, 12 Mason Street, Edge Hill, Liverpool.

Mason, Thomas, York.

Mather, Daniel, 58 Mount Pleasant, Liverpool.

Mather, John, 58 Mount Pleasant, Liverpool.

Maxwell, Robert Percival, Finebrogue, Downpatrick, Ireland.

Mayne, Rev. Charles, M.R.I.A., 22 Upper Merrion Street, Dublin.

Meadows, James, York Place, Rusholme near Manchester.

Meynell, Thomas, F.L.S., Aiskew House, Bedale, Yorkshire.

Michell, Rev. Richard, B.D., Prælector of Logic, Lincoln College, Oxford.

Miller, Patrick, M.D., Exeter.

Miller, William Allen, M.D., F.R.S., Professor of Chemistry in King's College, London.

Mills, John Robert, Bootham, York.

Milne, David, M.A., F.R.S.E., Edinburgh.

Milner, Wm. Ralph, Wakefield, Yorkshire.

Milner, William, Liverpool.

Moore, John Carrick, M.A., Sec. G.S., 4 Hyde Park Gate, Kensington Gore, London.

More, John Shank, Professor of the Law of Scotland in the University of Edinburgh, F.R.S.E., 35 King Street, Edinburgh.

Morris, Rev. Francis Orpen, B.A., Nafferton Vicarage near Driffield, Yorkshire.

Morton, Francis, James Street, Liverpool.

Moss, W. H., Kingston Terrace, Hull.

Murchison, Sir Roderick Impey, G.C.St.S., M.A., D.C.L., F.R.S., Director-General of the Geological Survey of the United Kingdom; 16 Belgrave Square, London.

Murray, John, C.E., 11 Great Queen Street, Westminster, London.

Muspratt, James Sheridan, Ph.D., College of Chemistry, Liverpool.

Napier, Captain Johnstone (74th Regiment), The Villa, Poughill, Bude, Cornwall.

Nasmyth, James, F.R.A.S., Patricroft near Manchester.

Newall, Robert Stirling, Gateshead-upon-Tyne.

Newlands, James, 2 Clare Terrace, Liverpool.

Newman, Francis William, Professor of Latin in University College, London; 7 Park Village East, Regent's Park, London.

Newman, William, Darley Hall near Barnsley, Yorkshire.

Newman, William Lewin, F.R.A.S., St. Helen's Square, York.

Nicholls, John Ashton, F.R.A.S., Ardwick Place, Manchester.

Nicholson, Cornelius, F.G.S., The Hill, Hornsey near London.
Nicholson, John A., M.D., M.R.I.A., Balrath, Kells, Co. Meath.

O'Reardon, John, M.D., 35 York Street, Dublin.
Orlebar, A. B., M.A.
Orpen, Charles Edward H., M.D., Cape of Good Hope.
Osler, A. Follett, F.R.S., Birmingham.
Outram, Sir Benjamin Fonseca, Knt., C.B., M.D., F.R.S., 1 Hanover Square, London.
Oxford, Samuel Wilberforce, D.D., Lord Bishop of, F.R.S., 61 Eaton Place, London.

Palmer, William, 6 Green Street, Bath.
Parker, Charles Stewart, Liverpool.
Pasley, Major-General Sir Charles William, Royal Engineers, C.B., D.C.L., F.R.S., 12 Norfolk Crescent, Hyde Park, London.
Patterson, Robert, (*Local Treasurer*), 3 College Square North, Belfast.
Pattinson, Hugh Lee, F.R.S., Scots House, Gateshead-upon-Tyne.
Pearsall, Thomas John, F.C.S., Trade Museum, Society of Arts, 18 John Street, Adelphi, London.
Peckover, Algernon, F.L.S., Wisbeach, Cambridgeshire.
Peckover, Daniel, Woodhall near Bradford, Yorkshire.
Peckover, William, F.S.A., Wisbeach, Cambridgeshire.
Pedler, Lieut.-Colonel Philip Warren, Mutley House near Plymouth.
Peel, George, Soho Iron Works, Ancoats, Manchester.
Perigal, Frederick, 28 Hereford Square, Brompton, London.
Peters, Edward, Temple Row, Birmingham.
Philips, Edward, 35 Church Street, Manchester.
Philips, Herbert, 35 Church Street, Manchester.
Philips, Mark, The Park near Manchester.
Phillips, John, M.A., F.R.S., V.P.G.S., Deputy Reader in Geology in the University of Oxford, (*Assistant General Secretary*); Magdalen Bridge, Oxford.
Philpott, Rev. Henry, D.D., Master of St. Catharine's Hall, Cambridge.
Pike, Ebenezer, Besborough, Cork.
Pitt, George, 11 Pembridge Villas, Bayswater, London.
Pollexfen, Rev. John Hutton, M.A., Rector of St. Runwald's, Colchester.
Pontey, Alexander, Plymouth.
Poppelwell, Matthew, Rosella Place, Tynemouth.
Porter, Henry John, Tandragee Castle, Co. Armagh.
Portlock, Lieut.-Colonel Joseph Ellison, Royal Engineers, F.R.S., Inspector of the Royal Military Academy, Woolwich.
Powell, Rev. Baden, M.A., F.R.S., Savilian Professor of Geometry in the University of Oxford; 6 Stanhope Street, Hyde Park Gardens, London.
Pratt, Samuel Peace, F.R.S., For.Sec.G.S., Clarendon Chambers, Hand Court, Bedford Row, London.
Preston, R. Berthon, 10 Abercrombie Square, Liverpool.
Prestwich, Joseph, jun., F.R.S., Sec. G.S., 20 Mark Lane, London.
Pretious, Thomas, Royal Dockyard, Pembroke.
Pritchard, Andrew, 162 Fleet St., London.
Prower, Rev. J. M., M.A., Swindon, Wiltshire.
Pumphrey, Charles, Rock Mill, Stroud, Gloucestershire.

Radford, William, M.D., Sidmouth.
Ramsay, Sir James, Bart., F.G.S., Bamff House, Perthshire.
Ramsay, William, M.A., F.S.S., Professor of Humanity in the University of Glasgow, (*Local Treasurer*); The College, Glasgow.
Rance, Henry, Cambridge.
Ransome, Robert, Iron Foundry, Ipswich.
Rawlins, John, Birmingham.
Rawson, Thomas William, Saville Lodge, Halifax.
Read, William Henry Rudston, M.A., F.L.S., Hayton near Pocklington, Yorkshire.
Reade, Rev. Joseph Bancroft, M.A., F.R.S., Stone Vicarage, Aylesbury.
Redfern, Peter, M.D., Lecturer in Anatomy and Physiology in the University of Aberdeen; 2 Crown Place East, Aberdeen.
Richardson, Sir John, M.D., C.B., F.R.S., Haslar Hospital, Gosport.
Riddell, Captain Charles J. B., R.A., F.R.S., Plumstead Common, Woolwich.
Roberts, Richard, Globe Works, Manchester.
Robinson, John, Shamrock Lodge, Athlone, Ireland.
Robson, Rev. John, D.D., Glasgow.
Rogers, Rev. Canon, M.A., Redruth, Cornwall.
Roget, Peter Mark, M.D., F.R.S., 18 Upper Bedford Place, Russell Square, London.

Ross, Captain Sir James Clark, R.N., D.C.L., F.R.S., Aston House, Aston Abbots, Aylesbury.
Rothwell, Peter, Bolton.
Roughton, William, jun., Kettering, Northamptonshire.
Rowland, John, 30 Terminus Road, Brighton.
Rowntree, Joseph, Pavement, York.
Rowntree, Joseph, Scarborough.
Royle, John Forbes, M.D., F.R.S., Professor of Materia Medica and Therapeutics in King's College, London; Heathfield Lodge, Acton, Middlesex.
Rushout, Capt. the Hon. George, M.P., F.G.S., 10 Bolton Street, Piccadilly, London.
Russell, William J., Owen's College, Manchester.
Ryland, Arthur, Birmingham.

Sabine, Colonel Edward, R.A., D.C.L., Treas. and V.P.R.S., (*General Secretary*), 13 Ashley Place, Westminster.
Salt, C. F., 88 Canning Street, Liverpool.
Salter, Thomas Bell, M.D., F.L.S., Ryde, Isle of Wight.
Sanders, William, F.G.S., (*Local Treasurer*), Park Street, Bristol.
Satterthwaite, Michael, M.D., Tulketh Hall near Preston.
Schemman, J. C., Hamburgh; at L. Thornton's, Esq., The Elms, Highgate, Birmingham.
Schofield, Robert, 1 Gresham Street, City, London.
Scholes, T. Seddon.
Scholey, William Stephenson, M.A., Clapham, London.
Scholfield, Edward, M.D., Doncaster.
Scoresby, Rev. William, D.D., F.R.S., Torquay.
Sedgwick, Rev. Adam, M.A., F.R.S., Woodwardian Professor of Geology in the University of Cambridge, and Canon of Norwich; Trinity College, Cambridge.
Shaen, William, 8 Bedford Row, London.
Shanks, James, C.E., 23 Garscube Place, Glasgow.
Sharp, William, F.R.S., Rugby.
Shaw, Charles Wright, Russell Street, Liverpool.
Sherrard, David Henry, 88 Upper Dorset Street, Dublin.
Shortrede, Captain Robert, F.R.A.S., H.E.I.C.'s Service, Aden.
Sillar, Zechariah, M.D., Rainford near Liverpool.
Simpson, Rev. Samuel, Douglas, Isle of Man.
Simpson, Thomas, M.D., Minster Yard, York.
Sirr, Rev. Joseph D'Arcy, D.D., M.R.I.A.
Slater, William, Princess Street, Manchester.
Sleeman, Philip, Windsor Terrace, Plymouth.
Smith, Rev. Geo. Sidney, D.D., M.R.I.A., Professor of Biblical Greek in the University of Dublin; Aughalurcher, Fivemile-Town, Co. Tyrone.
Smith, James, Seaforth near Liverpool.
Smith, John, Welton Garth near Hull.
Smith, Rev. Joseph Denham, Kingstown near Dublin.
Smith, Rev. Philip, B.A., Head Master of Mill Hill School, Hendon, Middlesex.
Smith, Robert Mackay, Bellevue Crescent, Edinburgh.
Smyth, C. Piazzi, Professor of Practical Astronomy in the University of Edinburgh; 1 Hill Side, Edinburgh.
Solly, Edward, F.R.S., Professor of Chemistry to the Horticultural Society of London; 15 Tavistock Square, London.
Solly, Samuel Reynolds, M.A., F.R.S., Surge Hill, King's Langley, Herts.
Sopwith, Thomas, F.R.S., Allenheads, Haydon Bridge, Northumberland.
Spence, Joseph, Pavement, York.
Spiers, Richard James, 14 St. Giles's Street, Oxford.
Spottiswoode, William, M.A., F.R.S., 12 James Street, Buckingham Gate, London.
Sprague, Thomas Bond, St. John's College, Cambridge.
Squire, Lovell, Falmouth.
Stainton, James Joseph, Lewisham, Kent.
Stanger, Joshua, Keswick, Cumberland.
Stokes, George Gabriel, M.A., D.C.L., Sec. R.S., Lucasian Professor of Mathematics in the University of Cambridge; Pembroke College, Cambridge.
Strickland, Arthur, Bridlington Quay, Yorkshire.
Strickland, Charles, Loughglyn, Ballaghadereen, Ireland.
Sykes, Lieut.-Col. William Henry, F.R.S., 47 Albion Street, Hyde Park, London.

Tayler, Rev. John James, B.A., Principal and Professor of Ecclesiastical History in Manchester New College, London.
Taylor, James, Todmorden Hall, Lancashire.
Taylor, John, F.R.S., (*General Treasurer*), 6 Queen Street Place, Upper Thames Street, London.
Taylor, John, jun., F.G.S., 6 Queen Street Place, Upper Thames Street, London.

Taylor, Richard, F.G.S., 6 Queen Street Place, Upper Thames Street, London.
Taylor, Captain Joseph Needham, R.N.
Taylor, Richard, F.L.S., Red Lion Court, Fleet Street, London.
Tennant, James, F.G.S., Professor of Geology and Mineralogy in King's College, London; 149 Strand, London.
Thodey, Winwood, 4 Poultry, London.
Thomas, George John, M.A.
Thompson, Corden, M.D., Sheffield.
Thompson, John, Little Stonegate, York.
Thomson, James, M.A., C.E., 16 Donegall Place, Belfast.
Thomson, James Gibson, Edinburgh.
Thomson, William, M.A., F.R.S., Professor of Natural Philosophy in the University of Glasgow; The College, Glasgow.
Thornton, Samuel, The Elms, Highgate, Birmingham.
Thorp, The Venerable Thomas, B.D., Archdeacon of Bristol, F.G.S.
Tidswell, Benjamin K., Brown Street, Manchester.
Tindal, Captain, R.N., Branch Bank of England, Birmingham.
Tinné, John A., F.R.G.S., Briarly Aigburth, Liverpool.
Townsend, Richard E., Springfield, Norwood.
Townsend, R. W., M.A., M.R.I.A., Rathmines Road, Dublin.
Trevelyan, Arthur, Wallington, Northumberland.
Tuckett, Francis Fox, Frenchay, Bristol.
Tulloch, James, F.R.S., 16 Montagu Place, Russell Square, London.
Turnbull, Rev. Thomas Smith, M.A., F.R.S., Blofield, Norfolk.
Tweedy, Wm. Mansell, Truro, Cornwall.

Vallack, Rev. Benj. W. S., St. Budeaux near Plymouth.
Vance, Rev. Robert, 16 Montpelier Hill, Dublin.
Vaux, Frederick.
Vernon, John, Hayman's Green, West Derby, Liverpool.
Vivian, H. Hussey, Swansea.

Walker, John, Weaste House, Pendleton, Manchester.
Walker, Joseph N., F.L.S., Calderston near Liverpool.
Walker, Rev. Robt., M.A., F.R.S., Reader in Experimental Philosophy in the University of Oxford; Culham Vicarage, Abingdon.
Walker, Thomas, 10 York Street, Manchester.
Warburton, Henry, M.A., F.R.S., 45 Cadogan Place, Sloane Street, London.
Ward, William Sykes, Leathley Lodge, Leeds.
Waterhouse, John, F.R.S., Halifax, Yorkshire.
Watson, Henry Hough, Bolton-le-Moors.
Way, J. Thomas, Professor of Chemistry, Royal Agricultural Society of England, Hanover Square, London.
Webb, Rev. Thomas William, M.A., Cloisters, Gloucester.
Western, T. B., Felix Hall, Kelvedon, Essex.
Westhead, Joshua Proctor, York House, Manchester.
Whewell, Rev. William, D.D., F.R.S., Master of Trinity College, Cambridge.
Whiteside, James, M.A., Q.C., M.P., 2 Mountjoy Square, Dublin.
Whitworth, Joseph, Manchester.
Wickenden, Joseph, F.G.S., Birmingham.
Wilberforce, Rev. Robert J.
Willert, Paul Ferdinand, Manchester.
Williams, Caleb, Micklegate, York.
Williams, Rev. D., D.C.L., Warden of New College, Oxford.
Williams, William, 6 Rood Lane, Fenchurch Street, London.
Williamson, Alex. W., Ph.D., Professor of Practical Chemistry in University College, London.
Williamson, Rev. William, B.D., Datchworth Rectory near Stevenage.
Wills, William, F.G.S., Edgbaston near Birmingham.
Wilson, Alexander, F.R.S., 34 Bryanstone Square, London.
Wilson, Capt. F., Dallam Tower, Milnthorpe, Westmoreland.
Wilson, John, Bootham, York.
Wilson, Sumner, Southampton.
Wilson, Thomas, Crimbles House, Leeds.
Wilson, William Parkinson, M.A., Professor of Pure and Applied Mathematics in the University of Melbourne.
Winsor, F. A., 57 Lincoln's Inn Fields, London.
Winterbottom, James Edward, M.A., F.L.S., East Woodhay, Hants.
Wollaston, Thomas Vernon, M.A., F.L.S., 25 Thurloe Square, Brompton, London.
Wood, Rt. Hon. Sir Charles, Bart., M.P., Admiralty, and Hickleston Hall, Doncaster.
Wood, John, St. Saviourgate, York.
Wood, Rev. William Spicer, M.A., Oakham, Rutlandshire.
Woodd, Charles H. L., F.G.S., Hillfield, Hampstead, London.

Woodhead, G., Mottram near Manchester.
Woods, Edward, 7 Church Street, Edgehill, Liverpool.
Worcester, Henry Pepys, D.D., Lord Bishop of, 24 Grosvenor Place, London.
Wormald, Richard, 12 Little Tower Street, London.
Worthington, Robert, Cheetham Hill near Manchester.
Wright, Robert Francis, Hinton Blewett, Somersetshire.
Yarborough, George Cooke, Camp's Mount, Doncaster.
Yates, Joseph Brooks, F.S.A., F.R.G.S., West Dingle near Liverpool.
Yates, R. Vaughan, Aigburth Road, Toxteth Park, Liverpool.
Yorke, Colonel Philip, F.R.S., 89 Eaton Place, Belgrave Square, London.
Younge, Robert, M.D., Greystones near Sheffield.

ANNUAL SUBSCRIBERS.

Abraham, John, Bold Street, Liverpool.
Aikin, John.
Alison, William P., M.D., F.R.S.Ed., Professor of the Practice of Physic in the University of Edinburgh; Edinburgh.
Allman, George James, M.D., F.R.S., M.R.I.A., Professor of Botany in the University of Dublin; Trinity College, Dublin.
Archer, Francis, Liverpool.
Archer, T. C., Tranmere, Cheshire.
Argyll, The Duke of, F.R.S., Hamilton Place, Piccadilly, London, and Inverary Castle, Inverary, Scotland.
Armstrong, William George, F.R.S., Newcastle-on-Tyne.

Baines, Samuel, Brighouse near Huddersfield.
Bakewell, Frederick, 6 Haverstock Terrace, Hampstead, London.
Barrington, Edward, Fassaroe, Bray, Ireland.
Barrington, Richard, Trafalgar Terrace, Kingstown, Dublin.
Baylis, C. O., M.D., 51 Hamilton Square, Liverpool.
Becker, Ernest, Buckingham Palace, London.
Bedford, James, Ph.D., New Brighton, Cheshire.
Beechey, Rear Admiral F. W., F.R.S., 8 Westbourne Crescent, Hyde Park, London.
Beke, Charles T., Ph.D., F.S.A.
Bellhouse, William Dawson, 17 Pembroke Place, Liverpool.
Benson, Starling, F.G.S., Gloucester Place, Swansea.
Bevan, John, Aigburth near Liverpool.
Bird, W. Smith, Dingle Priory, Toxteth Park, Liverpool.
Bishop, Rev. Francis, High Park Street, Liverpool.
Blundell, Henry, Brunswick House, Beverley Road, Hull.
Bolton, Thomas, Kinver near Stourbridge.
Bossey, Francis, M.D., Woolwich.
Boult, Joseph, 24 North John Street, Liverpool.
Brazier, James S., Marischal College and University, Aberdeen.
Bretherton, Frederick, Liverpool.
Brewin, Robert, Birstall Hall, Leicester.
Brewster, Sir David, K.H., D.C.L., F.R.S., V.P.R.S. Ed., Principal of the United College of St. Salvator and St. Leonard, St. Andrew's.
Bright, Edward B., 2 Exchange Buildings, Liverpool.
Brown, John, 3 Newcastle Place, Clerkenwell, London.
Brown, William, 25 Dublin Street, Edinburgh.
Browne, Henry, M.D., Manchester.
Burckhardt, Otte, Bank Chambers, Liverpool.
Burgess, John, Rastrick near Halifax.
Byerley, Isaac, Seacombe, Liverpool.

Cadell, William Monteith, Mersey Chambers, 9 Huskinson Street, Liverpool.
Caine, Nathaniel, Dutton Street, Liverpool.
Caine, William Sproston, Liverpool.
Calder, Rev. William, Fairfield Parsonage, Liverpool.
Calvert, Professor F. Crace, F.C.S., Royal Institution, Manchester.
Carpenter, Rev. R. Lant, B.A., Birkenhead.
Carpenter, William Benj., M.D., F.R.S., Professor of Medical Jurisprudence in University College, London; University Hall, Gordon Square, London.

Cator, J. B., Commander R.N., 1 Adelaide Street, Hull.
Chapple, Frederick, Canning Street, Liverpool.
Cheshire, Edward, 12 St. James's Square, London.
Claudet, A., F.R.S., 107 Regent Street, London.
Clay, Robert, St. Ann Street, Liverpool.
Clay, William, Rosebank, Beresford Road, Liverpool.
Close, Rev. Francis, Cheltenham.
Cockey, William, 18 Lansdowne Crescent, Glasgow.
Collingwood, Cuthbert, M.A., M.B., F.L.S., Blackheath, Kent.
Conolly, John, M.D., D.C.L., Hanwell.
Cooke, John, Howe Villa, Richmond, Yorkshire.
Cooke, Rev. William, M.A., St. Stephen's Parsonage, Hammersmith, London.
Cooper, Sir Henry, M.D., Hull.
Copland, James, M.D., F.R.S., 5 Old Burlington Street, London.
Crisp, M. F., Syndenham.
Crowe, John, 3 Mersey Chambers, Liverpool.
Cull, Richard, Hon. Sec. Ethnological Society; 13 Tavistock Street, Bedford Square, London.

Daglish, Robert, M. & C.E., Orrell Cottage near Wigan.
Daglish, Robert, jun., St. Helen s, Lancashire.
Dale, John A., M.A., 11 Holywell Street, Oxford.
Dale, Rev. Peter Steele, M.A., Hollingfare-in-Warrington.
Dashwood, Charles, Thornage, Norfolk.
Da Silva, Johnson, Percy Cross House, Fulham near London.
Deane, Henry, Clapham, London.
Denison, The Hon. William, Grimston, Tadcaster.
Dennis, J. C., F.R.A.S., 122 Bishopsgate Street, London.
Dickin, J. R., 29 Exchange Alley North, Liverpool.
Dickson, Peter, 24 Chester Terrace, Regent's Park, London.
Dixon, Hugh, Devonshire House, Claughton.
Dobbin, Orlando T., LL.D., M.R.I.A., Ballivor, Kells, Co. Meath.
Domvile, William C., F.Z.S., 5 Grosvenor Square, London.
Dufferin and Clandeboye, Viscount, Clandeboye, Holywood, Belfast.

Edwards, J. B., Ph.D., Berry Street, Liverpool.
Elcum, Charles Fred., 3 Crescent Terrace, Cheltenham.
Evans, Edward, Rock Ferry, Liverpool.
Evans, G. F. D., M.D., St. Mary's, Bedford.
Everest, Lt.-Colonel George, Bengal Artillery, F.R.S., 10 Westbourne Street, Hyde Park, London.
Everest, Robert, M.A., 11 Reform Club, Pall Mall, London.

Falconer, R. Wilbraham, M.D., Bath.
Fawcett, John, 4 Eaton Place, Brighton.
Ferguson, William, F.L.S., Kinmundy, Aberdeenshire.
Fielding, James, Sowerby Bridge near Halifax.
Fischal, Rev A., 4 Great George Square, Liverpool.
Fowler, Richard, M.D., F.R.S., Salisbury.

Gage, M. A., C.E., 24 Elizabeth Street, Liverpool.
Garston, Edgar, Aigburth, Liverpool.
Gassiot, John P., F.R.S., Clapham Common, London.
Gee, Robert, M.D., Oxford Street, Liverpool.
Gerard, Henry, 110 Canning Street, Liverpool.
Gibson, Thomas F., 124 Westbourne Terrace, Hyde Park, London.
Gillis, T. L., Basnett Street, Liverpool.
Gourley, Daniel De la C., M.D., Regent's Park, London.
Grantham, John, C.E., Liverpool.
Grantham, R. B., Liverpool.
Gravatt, William, F.R.S., 15 Park Street, Westminster.
Greenhalgh, Thomas, Bolton-le-Moors.
Greenwood, Henry, Harford House, Fairfield, Liverpool.
Greenwood, William, Stones, Todmorden, Lancashire.

Haddock, John, Prestatyn near Rhyl, Wales.
Hall, Hugh F., 16 Everton Terrace, Liverpool.
Hancock, John, Lurgan, Co. Armagh.
Hanson, Samuel, Epsom.
Harcourt, Rev. L. Vernon, West Dean House, Chichester.
Harkness, Robert, F.G.S., Professor of Geology in Queen's College, Cork.
Harrison, William, Whitehaven.
Hartnup, John, F.R.A.S., Observatory, Liverpool.
Hawkes, William, Eagle Foundry, Birmingham.
Healey, Elkanah, Gateacre.

Heath, Edward, Everton near Liverpool.
Heldenmaier, B., Ph.D., Worksop, Nottinghamshire.
Henfrey, Arthur, F.R.S., Professor of Botany in King's College, London, 4 Queen's Road, Camden Square, London.
Hervey, The Rev. Lord Arthur, Ickworth, Suffolk.
Heyworth, L., jun., Yew-Tree House, Liverpool.
Higgins, Rev. Henry H., Rainhill, Liverpool.
Highley, Samuel, F.G.S., 32 Fleet Street, London.
Hill, William, F.R.A.S., Worcester.
Hincks, Rev. Edward, D.D., Killyleagh, Ireland.
Hodgkinson, Rev. G. C., M.A., The Lodge, Louth, Yorkshire.
Holcroft, George, 82 Great Ducie Street, Strangeways, Manchester.
Horsfall, Thomas B., M.P., Liverpool.
Howson, Rev. J. S., South Hill, Toxteth Park, Liverpool.
Hudson, Robert, F.R.S., Clapham Common, London.
Hunt, Robert, F.R.S., Keeper of Mining Records, Museum of Practical Geology, Jermyn Street, London.
Huntingdon, Frederick, F.R.C.S.Ed., 19 George Street, Hull.

Ihne, William, Ph.D., Carlton Terrace, Liverpool.

Jacob, W. S., F.R.A.S., Madras.
Jacobs, Bethel, Hull.
Jeffreys, W. P., Washington Street, Liverpool.
Jennings, Thomas, F.C.S., Cork.
Johnston, A. Keith, 4 St. Andrew Square, Edinburgh.
Jones, Rev. Henry H., Manchester.
Jones, John, 34 Chapel Street, Liverpool.
Jones, R. L., Great George Square, Liverpool.

Kay, Alexander, Church Bank, Bowdon near Altrincham, Cheshire.
Kemp, Rev. Henry William, B.A., 33 George Street, Hull.
Kennedy, James, 33 Erskine Street, Liverpool.
Kilpin, Thomas Johnstone, 1 Arrad Street, Liverpool.
King, Alfred, 1 Netherfield Road South, Liverpool.
Kirkwood, Anderson, 1 Mansfield Place, Glasgow.

Lamport, W. J., Liverpool.
Lankester, Edwin, M.D., F.R.S., 8 Savile Row, London.
Latham, R. G., M.D., F.R.S., Upper Southwick Street, Edgware Road, London.
Lawson, Henry, F.R.S., Lansdowne Crescent, Bath.
Lawton, William, Manor House Street, Hull.
Lees, Samuel, Park Bridge, Ashton-under-Lyne.
Littledale, Thomas, Highfield, Liverpool.
Liveing, G. D., St. John's College, Cambridge.
Lloyd, F. Geisler, Belsize, Hampstead, London.

Macadam, Stevenson, Ph.D., F.C.S., Surgeons' Hall, Edinburgh.
M^cDermott, Edward, 11 The Terrace, Camberwell, London.
Macgregor, William, Falkner Street, Liverpool.
M^cGregor, Walter, Liverpool.
M^cIlveen, A. Sinclair, Sandon Terrace, Liverpool.
MacLaren, Charles, Moreland Cottage, Grange Loan, Edinburgh.
M^cNicholl, H., M.D., 42 Oxford Street, Liverpool.
Macrorie, Dr., 126 Duke Street, Liverpool.
Magrath, Rev. Folliot, A.M., Stradbally, Queen's Co., Ireland.
Malahide, Talbot de, Lord, Malahide Castle.
Malcolm, Andrew G., M.D., 49 York Street, Belfast.
Martindale, Nicholas, 15 Hanover Street, Liverpool.
May, Charles, F.R.S., 3 Great George Street, Westminster.
Melly, Charles Pierce, Liverpool.
Moffatt, T., Hawarden.
Moore, Thomas John, Keeper of the Derby Museum, Liverpool.
Morris, David, Manchester.
Murray, William, F.G.S., 160 West George Street, Glasgow.

Neale, Edward V., West Wickham, Kent.
Neild, William, Mayfield, Manchester.
Neill, William, Governor of Hull Gaol, Hull.
Neumann, Charles W., Wyncote, Allerton, Liverpool.
Newmarch, William, Secretary to the Globe Insurance, Cornhill, London.
Nicolay, Rev. C. G., King's College, Strand, London.
Noble, Matthew, 13 Bruton Street, Bond Street, London.

Oldham, James, C.E., 16 Parliament Street, Hull.
Orr, Andrew, Blythswood Square, Glasgow.
Outram, Thomas, Greetland near Halifax.

Pare, William, Seville Iron Works, Dublin.
Parker, William, Thornton-le-Moor, Lincolnshire.
Parr, Alfred, M.D., New Brighton, Cheshire.
Peach, C. W., Wick.
Pearson, J. A., Woolton, Liverpool.
Percy, John, M.D., F.R.S., Museum of Practical Geology, Jermyn Street, London.
Petrie, James, M.D., 13 Upper Parliament Street, Liverpool.
Petrie, William, Ecclesbourne Cottage, Woolwich.
Poole, Braithwaite, Kensington, London.
Potchett, Rev. William, M.A., The Vicarage, Grantham.
Prosser, Thomas, New York, United States.
Puckle, G. Hale, Royal Institution, Liverpool.

Raffles, Thomas Stamford, 31 Canning Street, Liverpool.
Ramsay, Andrew C., F.R.S., Director of the Geological Survey of Great Britain; Museum of Practical Geology, Jermyn Street, London.
Randall, William B., 146 High Street, Southampton.
Rankin, Rev. Thomas, Huggate, Yorkshire.
Rankine, W. J. Macquorn, C.E., F.R.S. L.&E., 59 St. Vincent Street, Glasgow.
Reid, David Boswell, M.D., 4 Great College Street, Westminster.
Richardson, John, Hull.
Rivaz, John V. C., 19 Cowley Street, Westminster.
Robberds, Rev. John, B.A., Liverpool.
Roberts, John Francis, Globe Works, Manchester.
Roberts, John, 12 Huskisson Street, Liverpool.
Robinson, C. B., The Shrubbery, Leicester.
Robinson, James, Aigburth, Liverpool.
Ronalds, Francis, F.R.S.
Round, Daniel George, Hange Colliery, near Tipton.

Sandbach, Henry R., Hafodunos, Denbighshire.
Sandon, Lord, 39 Gloucester Square, London.
Scholfield, Henry D., M.D., Liverpool.
Scrivenor, Harry, Somerville, Seacombe, Liverpool.
Sharpe, Robert, M.D., Coleraine.
Shaw, Norton, M.D., Secretary to the Royal Geographical Society, 3 Waterloo Place, London.
Shewell, J. T., Rushmere, Ipswich.
Sleddon, Francis, Lansdowne Terrace, Hull.
Sloper, George Elgar, jun., Devizes.
Sloper, Samuel W., Devizes.
Smith, John, Commerce Court, Liverpool.
Smith, Robert Angus, Ph.D., 20 Grosvenor Square, Manchester.
Smith, William, Woodside Works, Paisley.
Smyth, John, jun.,, M.A., C.E., Milltown, Banbridge, Ireland.
Smythe, Capt. W. J., R.A., Woolwich.
Sorby, John Clifton, Park, Birkenhead.
Spence, Peter, Pendleton, Manchester.
Spence, William, F.R.S., V.P.L.S., 18 Lower Seymour Street, Portman Square, London.
Spence, W. B., 18 Lower Seymour Street, Portman Square, London.
Stevelly, John, LL.D., Professor of Natural Philosophy in Queen's College, Belfast.
Stoess, Charles (Consul), 6 Cook Street, Liverpool.
Stone, George, Prospect House, Fairfield near Liverpool.
Stuart, William, Knotty Ash, Liverpool.

Talbot, William Hawkshead, Wrightington near Wigan.
Tate, Lt.-Colonel, Liverpool.
Taylor, Dr. H. R., 1 Percy Street, Liverpool.
Taylor, William Edward, Blackburn.
Terry, John, 15 Albion Street, Hull.
Teschemacher, E. F., 1 College Road, Highbury Park, London.
Thompson, Benj. James, 3 High Street, Liverpool.
Thompson, D. P., M.D., 4 Salisbury Street, Liverpool.
Thompson, Edmund, Claughton Park, Birkenhead.
Thorburn, William, M.D., 11 St. Paul's Square, Liverpool.
Thorburn, Rev. William Reid, M.A., Starkies, Bury, Lancashire.
Tooke, Thomas, F.R.S., 31 Spring Gardens, London.
Towson, John Thomas, 23 Great George Square, Liverpool.
Turnbull, James, M.D., Mornington Terrace, Liverpool.
Tuton, Edward S., Lime Street, Liverpool.
Twining, Richard, F.R.S., 13 Bedford Place, Russell Square, London.
Tyndall, John, Ph.D., F.R.S., Professor of Natural Philosophy in the Royal Insti-

tution of Great Britain; 9 Chadwell Street, Myddelton Square, London.

Vale, James Th., Hamilton Square, Birkenhead.
Varley, Cornelius, 1 Charles Street, Clarendon Square, London.
Varley, Cromwell F., 1 Charles Street, Clarendon Square, London.

Walker, Charles V., Electric Telegraph, South Eastern Railway, Tunbridge.
Warington, Robert, F.C.S., Apothecaries' Hall, London.
Waterhouse, Nicholas, 5 Rake Lane, Liverpool.
Watkins, James, Bolton.
Watt, William, Flax Works, Bedford Street, Belfast.
Watts, John King, F.R.G.S., St. Ives, Huntingdonshire.
Weightman, William Henry, Litherland, Liverpool.
Wheatley, E. B., Cote Wall, Merfield, Yorkshire.
Whitty, John Irwine, LL.D., C.E., 4 Trafalgar Square, London; and 16 Henrietta Street, Dublin.
Whitehead, James W., 15 Duke Street, Edge Hill, Liverpool.
Wigham, Robert, Norwich.
Wight, Robert, M.D., F.L.S., Grazeley Lodge, Reading.
Williams, William, 26 St. James's Road, Liverpool.
Winter, Thomas, Cranford, Lincolnshire.
Woodall, John Woodall, St. Nicholas House, Scarborough.
Worden, John, 9 Junction Street, Hull.
Wornell, George, 2 Crescent, Park Town, Oxford.

Zwilchenbart, Emanuel, Roselands, Aigburth, Liverpool.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The Published Reports of Proceedings at the Meetings of the Association may be obtained by *Members* on application to the under-mentioned Local Treasurers, or Agents appointed by them, at the following prices, viz.—Reports for 1849, 1850, 1851, 1852, 1853, 1854, at two-thirds of the Publication Price; and for the purpose of completing their sets, any of the first seventeen volumes, *of which more than* 100 *copies remain*, at one-third of the Publication Price.

	TREASURER.	DEPOT FOR THE REPORTS.
LONDON	John Taylor, Esq., F.R.S. 6 Queen Street Place, Upper Thames Street.	Messrs. Taylor & Francis, Printing Office, Red Lion Court, Fleet Street.

	LOCAL TREASURERS.	DEPOTS.
YORK	William Gray, Esq., F.G.S.	Yorkshire Museum.
CAMBRIDGE	C. C. Babington, Esq., M.A., F.R.S.	House of the Philosophical Society.
EDINBURGH	William Brand, Esq.	Union Bank of Scotland.
DUBLIN	John H. Orpen, LL.D.	13 South Frederick Street.
BRISTOL	William Sanders, Esq., F.G.S.	Philosophical Institution, Park Street.
LIVERPOOL	Robert McAndrew, Esq., F.R.S.	7 North John Street.
BIRMINGHAM	W. R. Wills, Esq.	Birmingham.
GLASGOW	Professor Ramsay, M.A.	The College.
MANCHESTER	R. P. Greg, Esq.	Chancery Lane.
SOUTHAMPTON	John Sadleir Moody, Esq.	Southampton.
SWANSEA	John Gwyn Jeffreys, Esq., F.R.S.	Swansea.
IPSWICH	J. B. Alexander, Esq.	North Gate House.
BELFAST	Robert Patterson, Esq.	High Street.
HULL	Edmund Smith, Esq.	Hull.

Associates for the Meeting in 1854 may obtain the Volume for the Year at the same price as Members.

PROCEEDINGS OF THE FIRST AND SECOND MEETINGS, at York and Oxford, 1831 and 1832, *Published at* 13*s.* 6*d.*

CONTENTS:—Prof. Airy, on the Progress of Astronomy;—J. W. Lubbock, on the Tides;—Prof. Forbes, on the Present State of Meteorology;—Prof. Powell, on the Present State of the Science of Radiant Heat;—Prof. Cumming, on Thermo-Electricity;—Sir D. Brewster, on the Progress of Optics;—Rev. W. Whewell, on the Present State of Mineralogy;—Rev. W. D. Conybeare, on the Recent Progress and Present State of Geology;—Dr. Prichard's Review of Philological and Physical Researches.

Together with Papers on Mathematics, Optics, Acoustics, Magnetism, Electricity, Chemistry, Meteorology, Geography, Geology, Zoology, Anatomy, Physiology, Botany, and the Arts; and an Exposition of the Objects and Plan of the Association, &c.

PROCEEDINGS OF THE THIRD MEETING at Cambridge, 1833, *Published at* 12*s.*

CONTENTS:—Proceedings of the Meeting;—John Taylor, on Mineral Veins;—Dr. Lindley, on the Philosophy of Botany;—Dr. Henry, on the Physiology of the Nervous System;—P. Barlow, on the Strength of Materials;—S. H. Christie, on the Magnetism of the Earth;—Rev. J. Challis, on the Analytical Theory of Hydrostatics and Hydrodynamics;—G. Rennie, on Hydraulics as a Branch of Engineering, Part I.;—Rev. G. Peacock, on certain Branches of Analysis.

Together with papers on Mathematics and Physics, Philosophical Instruments and Mechanical Arts, Natural History, Anatomy, Physiology, and History of Science.

PROCEEDINGS OF THE FOURTH MEETING, at Edinburgh, 1834, *Published at* 15*s*.

CONTENTS:—H. G. Rogers, on the Geology of North America;—Dr. C. Henry, on the Laws of Contagion; Prof. Clark, on Animal Physiology;—Rev. L. Jenyns, on Zoology;—Rev. J. Challis, on Capillary Attraction;—Prof. Lloyd, on Physical Optics;—G. Rennie, on Hydraulics, Part II.

Together with the Transactions of the Sections, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE FIFTH MEETING, at Dublin, 1835, *Published at* 13*s*. 6*d*.

CONTENTS:—Rev. W. Whewell, on the Recent Progress and Present Condition of the Mathematical Theories of Electricity, Magnetism, and Heat; — A. Quetelet, Aperçu de l'Etat actuel des Sciences Mathématiques chez les Belges;—Capt. E. Sabine, on the Phænomena of Terrestrial Magnetism.

Together with the Transactions of the Sections, Prof. Sir W. Hamilton's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE SIXTH MEETING, at Bristol, 1836, *Published at* 12*s*.

CONTENTS:—Prof. Daubeny, on the Present State of our Knowledge with respect to Mineral and Thermal Waters;—Major E. Sabine, on the Direction and Intensity of the Terrestrial Magnetic Force in Scotland;—J. Richardson, on North American Zoology;—Rev. J. Challis, on the Mathematical Theory of Fluids;—J. T. Mackay, a Comparative View of the more remarkable Plants which characterize the neighbourhood of Dublin and Edinburgh, and the South-west of Scotland, &c.;—J. T. Mackay, Comparative Geographical Notices of the more remarkable Plants which characterize Scotland and Ireland;—Report of the London Sub-Committee of the Medical Section on the Motions and Sounds of the Heart;—Second Report of the Dublin Sub-Committee on the Motions and Sounds of the Heart;—Report of the Dublin Committee on the Pathology of the Brain and Nervous System;—J. W. Lubbock, Account of the Recent Discussions of Observations of the Tides;—Rev. B. Powell, on determining the Refractive Indices for the Standard Rays of the Solar Spectrum in various media;—Dr. Hodgkin, on the Communication between the Arteries and Absorbents;—Prof. Phillips, Report of Experiments on Subterranean Temperature;—Prof. Hamilton, on the Validity of a Method recently proposed by G. B. Jerrard, for Transforming and Resolving Equations of Elevated Degrees.

Together with the Transactions of the Sections, Prof. Daubeny's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE SEVENTH MEETING, at Liverpool, 1837, *Published at* 16*s*. 6*d*.

CONTENTS:—Major E. Sabine, on the Variations of the Magnetic Intensity observed at different points of the Earth's Surface;—Rev. W. Taylor, on the various modes of Printing for the Use of the Blind;—J. W. Lubbock, on the Discussions of Observations of the Tides;—Prof. T. Thomson, on the Difference between the Composition of Cast Iron produced by the Cold and Hot Blast;—Rev. T. R. Robinson, on the Determination of the Constant of Nutation by the Greenwich Observations;—R. W. Fox, Experiments on the Electricity of Metallic Veins, and the Temperature of Mines;—Provisional Report of the Committee of the Medical Section of the British Association, appointed to investigate the Composition of Secretions, and the Organs producing them;—Dr. G. O. Rees, Report from the Committee for inquiring into the Analysis of the Glands, &c. of the Human Body;—Second Report of the London Sub-Committee of the British Association Medical Section, on the Motions and Sounds of the Heart;—Prof. Johnston, on the Present State of our Knowledge in regard to Dimorphous Bodies;—Lt.-Col. Sykes, on the Statistics of the Four Collectorates of Dukhun, under the British Government;—E. Hodgkinson, on the relative Strength and other Mechanical Properties of Iron obtained from the Hot and Cold Blast;—W. Fairbairn, on the Strength and other Properties of Iron obtained from the Hot and Cold Blast;—Sir J. Robison, and J. S. Russell, Report of the Committee on Waves;—Note by Major Sabine, being an Appendix to his Report on the Variations of the Magnetic Intensity observed at different Points of the Earth's Surface;—J. Yates, on the Growth of Plants under Glass, and without any free communication with the outward Air, on the Plan of Mr. N. J. Ward, of London.

Together with the Transactions of the Sections, Prof. Traill's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS of the EIGHTH MEETING, at Newcastle, 1838, *Published at* 15*s*.

Contents :—Rev. W. Whewell, Account of a Level Line, measured from the Bristol Channel to the English Channel, by Mr. Bunt ;—Report on the Discussions of Tides, prepared under the direction of the Rev. W. Whewell ;—W. S. Harris, Account of the Progress and State of the Meteorological Observations at Plymouth ;—Major E. Sabine, on the Magnetic Isoclinal and Isodynamic Lines in the British Islands ;—D. Lardner, LL.D., on the Determination of the Mean Numerical Values of Railway Constants ;—R. Mallet, First Report upon Experiments upon the Action of Sea and River Water upon Cast and Wrought Iron ;—R. Mallet, on the Action of a Heat of 212° Fahr., when long continued, on Inorganic and Organic Substances.

Together with the Transactions of the Sections, Mr. Murchison's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS of the NINTH MEETING, at Birmingham, 1839, *Published at* 13*s*. 6*d*.

Contents :—Rev. B. Powell, Report on the Present State of our Knowledge of Refractive Indices, for the Standard Rays of the Solar Spectrum in different media ;—Report on the Application of the Sum assigned for Tide Calculations to Rev. W. Whewell, in a Letter from T. G. Bunt, Esq. ;—H. L. Pattinson, on some galvanic Experiments to determine the Existence or Non-Existence of Electrical Currents among Stratified Rocks, particularly those of the Mountain Limestone formation, constituting the Lead Measures of Alston Moor ;—Sir D. Brewster, Reports respecting the two series of Hourly Meteorological Observations kept in Scotland ;—Report on the subject of a series of Resolutions adopted by the British Association at their Meeting in August 1838, at Newcastle ;—R. Owen, Report on British Fossil Reptiles ;—E. Forbes, Report on the Distribution of pulmoniferous Mollusca in the British Isles ;—W. S. Harris, Third Report on the Progress of the Hourly Meteorological Register at the Plymouth Dockyard.

Together with the Transactions of the Sections, Rev. W. Vernon Harcourt's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS of the TENTH MEETING, at Glasgow, 1840, *Published at* 15*s*.

Contents :—Rev. B. Powell, Report on the recent Progress of discovery relative to Radiant Heat, supplementary to a former Report on the same subject inserted in the first volume of the Reports of the British Association for the Advancement of Science ;—J. D. Forbes, Supplementary Report on Meteorology ;—W. S. Harris, Report on Prof. Whewell's Anemometer, now in operation at Plymouth ;—Report on "The Motions and Sounds of the Heart," by the London Committee of the British Association, for 1839–40 ;—Prof. Schönbein, an Account of Researches in Electro-Chemistry ;—R. Mallet, Second Report upon the Action of Air and Water, whether fresh or salt, clear or foul, and at various temperatures, upon Cast Iron, Wrought Iron and Steel ;—R. W. Fox, Report on some Observations on Subterranean Temperature ;—A. F. Osler, Report on the Observations recorded during the years 1837, 1838, 1839 and 1840, by the Self-registering Anemometer erected at the Philosophical Institution, Birmingham ;—Sir D. Brewster, Report respecting the two Series of Hourly Meteorological Observations kept at Inverness and Kingussie, from Nov. 1st, 1838 to Nov. 1st, 1839 ;—W. Thompson, Report on the Fauna of Ireland : Div. *Vertebrata* ;—C. J. B. Williams, M.D., Report of Experiments on the Physiology of the Lungs and Air-Tubes ;—Rev. J. S. Henslow, Report of the Committee on the Preservation of Animal and Vegetable Substances.

Together with the Transactions of the Sections, Mr. Murchison and Major E. Sabine's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS of the ELEVENTH MEETING, at Plymouth, 1841, *Published at* 13*s*. 6*d*.

Contents :—Rev. P. Kelland, on the Present state of our Theoretical and Experimental Knowledge of the Laws of Conduction of Heat ;—G. L. Roupell, M.D., Report on Poisons ;—T. G. Bunt, Report on Discussions of Bristol Tides, under the direction of the Rev. W. Whewell ;—D. Ross, Report on the Discussions of Leith Tide Observations, under the direction of the Rev. W. Whewell ;—W. S. Harris, upon the working of Whewell's Anemometer at Plymouth during the past year ;—Report of a Committee appointed for the purpose of superintending the scientific co-operation of the British Association in the System of Simultaneous Observations in Terrestrial Magnetism and Meteorology ;—Reports of Committees appointed to provide Meteorological Instruments for the use of M. Agassiz and Mr. M'Cord ;—Report of a Committee to superintend the reduction of Meteorological Observations ;—Report of a Committee for revising the Nomenclature of the Stars ;—Report of a Committee for obtaining Instruments and registers to record Shocks and Earthquakes in Scotland and Ireland ;—Report of a Committee on the Preservation of Vegetative Powers in Seeds;—Dr. Hodgkin, on Inquiries into the Races of Man;—Report of the Committee appointed to report how far the Desiderata in our knowledge of the Condition of the Upper Strata of the Atmosphere may be supplied by means of Ascents in Balloons or otherwise, to ascertain the probable expense of such Experiments, and to draw up Directions for Observers in such circumstances;—R. Owen, Report on British Fossil Reptiles;—Reports on the Determination of the Mean Value of Railway Constants;—D. Lardner, LL.D., Second and concluding Report on the Determination of the Mean Value of Railway Constants;—E. Woods, Report on Railway Constants;—Report of a Committee on the Construction of a Constant Indicator for Steam-Engines.

Together with the Transactions of the Sections, Prof. Whewell's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWELFTH MEETING, at Manchester, 1842, *Published at* 10*s*. 6*d*.

CONTENTS:—Report of the Committee appointed to conduct the co-operation of the British Association in the System of Simultaneous Magnetical and Meteorological Observations;—J. Richardson, M.D., Report on the present State of the Ichthyology of New Zealand;—W. S. Harris, Report on the Progress of Meteorological Observations at Plymouth;—Second Report of a Committee appointed to make Experiments on the Growth and Vitality of Seeds;—C. Vignoles, Report of the Committee on Railway Sections;—Report of the Committee for the Preservation of Animal and Vegetable Substances;—Lyon Playfair, M.D., Abstract of Prof. Liebig's Report on "Organic Chemistry applied to Physiology and Pathology;"—R. Owen, Report on the British Fossil Mammalia, Part I.;—R. Hunt, Researches on the Influence of Light on the Germination of Seeds and the Growth of Plants;—L. Agassiz, Report on the Fossil Fishes of the Devonian System or Old Red Sandstone;—W. Fairbairn, Appendix to a Report on the Strength and other Properties of Cast Iron obtained from the Hot and Cold Blast;—D. Milne, Report of the Committee for registering Shocks of Earthquakes in Great Britain;—Report of a Committee on the Construction of a Constant Indicator for Steam-Engines, and for the determination of the Velocity of the Piston of the Self-acting Engine at different periods of the Stroke;—J. S. Russell, Report of a Committee on the form of Ships;—Report of a Committee appointed "to consider of the rules by which the Nomenclature of Zoology may be established on a uniform and permanent basis;"—Report of a Committee on the Vital Statistics of large Towns in Scotland;—Provisional Reports, and Notices of Progress in Special Researches entrusted to Committees and Individuals.

Together with the Transactions of the Sections, Lord Francis Egerton's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE THIRTEENTH MEETING, at Cork, 1843, *Published at* 12*s*.

CONTENTS:—Robert Mallet, Third Report upon the Action of Air and Water, whether fresh or salt, clear or foul, and of Various Temperatures, upon Cast Iron, Wrought Iron and Steel;—Report of the Committee appointed to conduct the co-operation of the British Association in the System of Simultaneous Magnetical and Meteorological Observations;—Sir J. F. W. Herschel, Bart., Report of the Committee appointed for the Reduction of Meteorological Observations;—Report of the Committee appointed for Experiments on Steam-Engines;—Report of the Committee appointed to continue their Experiments on the Vitality of Seeds;—J. S. Russell, Report of a Series of Observations on the Tides of the Frith of Forth and the East Coast of Scotland;—J. S. Russell, Notice of a Report of the Committee on the Form of Ships;—J. Blake, Report on the Physiological Action of Medicines;—Report of the Committee on Zoological Nomenclature;—Report of the Committee for Registering the Shocks of Earthquakes, and making such Meteorological Observations as may appear to them desirable;—Report of the Committee for conducting Experiments with Captive Balloons;—Prof. Wheatstone, Appendix to the Report;—Report of the Committee for the Translation and Publication of Foreign Scientific Memoirs;—C. W. Peach, on the Habits of the Marine Testacea;—E. Forbes, Report on the Mollusca and Radiata of the Ægean Sea, and on their distribution, considered as bearing on Geology;—L. Agassiz, Synoptical Table of British Fossil Fishes, arranged in the order of the Geological Formations;—R. Owen, Report on the British Fossil Mammalia, Part II.;—E. W. Binney, Report on the excavation made at the junction of the Lower New Red Sandstone with the Coal Measures at Collyhurst;—W. Thompson, Report on the Fauna of Ireland: Div. *Invertebrata*;—Provisional Reports, and Notices of Progress in Special Researches entrusted to Committees and Individuals.

Together with the Transactions of the Sections, Earl of Rosse's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE FOURTEENTH MEETING, at York, 1844, *Published at £1.*

Contents:—W. B. Carpenter, on the Microscopic Structure of Shells;—J. Alder and A. Hancock, Report on the British Nudibranchiate Mollusca;—R. Hunt, Researches on the Influence of Light on the Germination of Seeds and the Growth of Plants;—Report of a Committee appointed by the British Association in 1840, for revising the Nomenclature of the Stars;—Lt.-Col. Sabine, on the Meteorology of Toronto in Canada;—J. Blackwall, Report on some recent researches into the Structure, Functions and Œconomy of the *Araneidea* made in Great Britain;—Earl of Rosse, on the Construction of large Reflecting Telescopes;—Rev. W. V. Harcourt, Report on a Gas Furnace for Experiments on Vitrifaction and other Applications of High Heat in the Laboratory;—Report of the Committee for Registering Earthquake Shocks in Scotland;—Report of a Committee for Experiments on Steam-Engines;—Report of the Committee to investigate the Varieties of the Human Race;—Fourth Report of a Committee appointed to continue their Experiments on the Vitality of Seeds;—W. Fairbairn, on the Consumption of Fuel and the prevention of Smoke;—F. Ronalds, Report concerning the Observatory of the British Association at Kew;—Sixth Report of the Committee appointed to conduct the Co-operation of the British Association in the System of Simultaneous Magnetical and Meteorological Observations;—Prof. Forchhammer on the influence of Fucoidal Plants upon the Formations of the Earth, on Metamorphism in general, and particularly the Metamorphosis of the Scandinavian Alum Slate;—H. E. Strickland, Report on the recent Progress and present State of Ornithology;—T. Oldham, Report of Committee appointed to conduct Observations on Subterranean Temperature in Ireland;—Prof. Owen, Report on the Extinct Mammals of Australia, with descriptions of certain Fossils indicative of the former existence in that Continent of large Marsupial Representatives of the Order Pachydermata;—W. S. Harris, Report on the working of Whewell and Osler's Anemometers at Plymouth, for the years 1841, 1842, 1843;—W. R. Birt, Report on Atmospheric Waves;—L. Agassiz, Report sur les Poissons Fossiles de l'Argile de Londres, with translation;—J. S. Russell, Report on Waves;—Provisional Reports, and Notices of Progress in Special Researches entrusted to Committees and Individuals.

Together with the Transactions of the Sections, Dean of Ely's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE FIFTEENTH MEETING, at Cambridge, 1845, *Published at 12s.*

Contents:—Seventh Report of a Committee appointed to conduct the Co-operation of the British Association in the System of Simultaneous Magnetical and Meteorological Observations;—Lt.-Col. Sabine, on some points in the Meteorology of Bombay;—J. Blake, Report on the Physiological Action of Medicines;—Dr. Von Boguslawski, on the Comet of 1843;—R. Hunt, Report on the Actinograph;—Prof. Schönbein, on Ozone;—Prof. Erman, on the Influence of Friction upon Thermo-Electricity;—Baron Senftenberg, on the Self-Registering Meteorological Instruments employed in the Observatory at Senftenberg;—W. R. Birt, Second Report on Atmospheric Waves;—G. R. Porter, on the Progress and Present Extent of Savings' Banks in the United Kingdom;—Prof. Bunsen and Dr. Playfair, Report on the Gases evolved from Iron Furnaces, with reference to the Theory of Smelting of Iron;—Dr. Richardson, Report on the Ichthyology of the Seas of China and Japan;—Report of the Committee on the Registration of Periodical Phænomena of Animals and Vegetables;—Fifth Report of the Committee on the Vitality of Seeds;—Appendix, &c.

Together with the Transactions of the Sections, Sir J. F. W. Herschel's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE SIXTEENTH MEETING, at Southampton, 1846, *Published at 15s.*

Contents:—G. G. Stokes, Report on Recent Researches in Hydrodynamics;—Sixth Report of the Committee on the Vitality of Seeds;—Dr. Schunck, on the Colouring Matters of Madder;—J. Blake, on the Physiological Action of Medicines;—R. Hunt, Report on the Actinograph;—R. Hunt, Notices on the Influence of Light on the Growth of Plants;—R. L. Ellis, on the Recent Progress of Analysis;—Prof. Forchhammer, on Comparative Analytical Researches on Sea Water;—A. Erman, on the Calculation of the Gaussian Constants for 1829;—G. R. Porter, on the Progress, present Amount, and probable future Condition of the Iron Manufacture in Great Britain;—W. R. Birt, Third Report on Atmospheric Waves;—Prof. Owen, Report on the Archetype and Homologies of the Vertebrate Skeleton;—J. Phillips, on Anemometry;—J. Percy, M D., Report on the Crystalline Slags;—Addenda to Mr. Birt's Report on Atmospheric Waves.

Together with the Transactions of the Sections, Sir R. I. Murchison's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE SEVENTEENTH MEETING, at Oxford, 1847, *Published at* 18*s*.

CONTENTS:—Prof. Langberg, on the Specific Gravity of Sulphuric Acid at different degrees of dilution, and on the relation which exists between the Development of Heat and the coincident contraction of Volume in Sulphuric Acid when mixed with Water;—R. Hunt, Researches on the Influence of the Solar Rays on the Growth of Plants;—R. Mallet, on the Facts of Earthquake Phænomena;—Prof. Nilsson, on the Primitive Inhabitants of Scandinavia;—W. Hopkins, Report on the Geological Theories of Elevation and Earthquakes;—Dr. W. B. Carpenter, Report on the Microscopic Structure of Shells;—Rev. W. Whewell and Sir James C. Ross, Report upon the Recommendation of an Expedition for the purpose of completing our knowledge of the Tides;—Dr. Schunck, on Colouring Matters;—Seventh Report of the Committee on the Vitality of Seeds;—J. Glynn, on the Turbine or Horizontal Water-Wheel of France and Germany;—Dr. R. G. Latham, on the present state and recent progress of Ethnographical Philology;—Dr. J. C. Prichard, on the various methods of Research which contribute to the Advancement of Ethnology, and of the relations of that Science to other branches of Knowledge;—Dr. C. C. J. Bunsen, on the results of the recent Egyptian researches in reference to Asiatic and African Ethnology, and the Classification of Languages;—Dr. C. Meyer, on the Importance of the Study of the Celtic Language as exhibited by the Modern Celtic Dialects still extant;—Dr. Max Müller, on the Relation of the Bengali to the Arian and Aboriginal Languages of India;—W. R. Birt, Fourth Report on Atmospheric Waves;—Prof. W. H. Dove, Temperature Tables; with Introductory Remarks by Lieut.-Col. E. Sabine;—A. Erman and H. Petersen, Third Report on the Calculation of the Gaussian Constants for 1829.

Together with the Transactions of the Sections, Sir Robert Harry Inglis's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE EIGHTEENTH MEETING, at Swansea, 1848, *Published at* 9*s*.

CONTENTS:—Rev. Prof. Powell, A Catalogue of Observations of Luminous Meteors;—J. Glynn, on Water-pressure Engines;—R. A. Smith, on the Air and Water of Towns;—Eighth Report of Committee on the Growth and Vitality of Seeds;—W. R. Birt, Fifth Report on Atmospheric Waves;—E. Schunck, on Colouring Matters;—J. P. Budd, on the advantageous use made of the gaseous escape from the Blast Furnaces at the Ystalyfera Iron Works;—R. Hunt, Report of progress in the investigation of the Action of Carbonic Acid on the Growth of Plants allied to those of the Coal Formations;—Prof. H. W. Dove, Supplement to the Temperature Tables printed in the Report of the British Association for 1847;—Remarks by Prof. Dove on his recently constructed Maps of the Monthly Isothermal Lines of the Globe, and on some of the principal Conclusions in regard to Climatology deducible from them; with an introductory Notice by Lt.-Col. E. Sabine;—Dr. Daubeny, on the progress of the investigation on the Influence of Carbonic Acid on the Growth of Ferns;—J. Phillips, Notice of further progress in Anemometrical Researches;—Mr. Mallet's Letter to the Assistant-General Secretary;—A. Erman, Second Report on the Gaussian Constants;—Report of a Committee relative to the expediency of recommending the continuance of the Toronto Magnetical and Meteorological Observatory until December 1850.

Together with the Transactions of the Sections, the Marquis of Northampton's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE NINETEENTH MEETING, at Birmingham, 1849, *Published at* 10*s*.

CONTENTS:—Rev. Prof. Powell, A Catalogue of Observations of Luminous Meteors;—Earl of Rosse, Notice of Nebulæ lately observed in the Six-feet Reflector;—Prof. Daubeny, on the Influence of Carbonic Acid Gas on the health of Plants, especially of those allied to the Fossil Remains found in the Coal Formation;—Dr. Andrews, Report on the Heat of Combination;—Report of the Committee on the Registration of the Periodic Phænomena of Plants and Animals;—Ninth Report of Committee on Experiments on the Growth and Vitality of Seeds;—F. Ronalds, Report concerning the Observatory of the British Association at Kew, from Aug. 9, 1848 to Sept. 12, 1849;—R. Mallet, Report on the Experimental Inquiry on Railway Bar Corrosion;—W. R. Birt, Report on the Discussion of the Electrical Observations at Kew.

Together with the Transactions of the Sections, the Rev. T. R. Robinson's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWENTIETH MEETING, at Edinburgh, 1850, *Published at* 15*s*.

Contents:—R Mallet, First Report on the Facts of Earthquake Phænomena;—Rev. Prof. Powell, on Observations of Luminous Meteors;—Dr. T. Williams, on the Structure and History of the British Annelida;—T. C. Hunt, Results of Meteorological Observations taken at St. Michael's from the 1st of January, 1840 to the 31st of December, 1849;—R. Hunt, on the present State of our Knowledge of the Chemical Action of the Solar Radiations;—Tenth Report of Committee on Experiments on the Growth and Vitality of Seeds;—Major-Gen. Briggs, Report on the Aboriginal Tribes of India;—F. Ronalds, Report concerning the Observatory of the British Association at Kew;—E. Forbes, Report on the Investigation of British Marine Zoology by means of the Dredge;—R. MacAndrew, Notes on the Distribution and Range in depth of Mollusca and other Marine Animals, observed on the coasts of Spain, Portugal, Barbary, Malta, and Southern Italy in 1849;—Prof. Allman, on the Present State of our Knowledge of the Freshwater Polyzoa;—Registration of the Periodical Phænomena of Plants and Animals;—Suggestions to Astronomers for the Observation of the Total Eclipse of the Sun on July 28, 1851.

Together with the Transactions of the Sections, Sir David Brewster's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWENTY-FIRST MEETING, at Ipswich, 1851, *Published at* 16*s*. 6*d*.

Contents:—Rev. Prof. Powell, on Observations of Luminous Meteors;—Eleventh Report of Committee on Experiments on the Growth and Vitality of Seeds;—Dr. J. Drew, on the Climate of Southampton;—Dr. R. A. Smith, on the Air and Water of Towns: Action of Porous Strata, Water and Organic Matter;—Report of the Committee appointed to consider the probable Effects in an Œconomical and Physical Point of View of the Destruction of Tropical Forests;—A. Henfrey, on the Reproduction and supposed Existence of Sexual Organs in the Higher Cryptogamous Plants;—Dr. Daubeny, on the Nomenclature of Organic Compounds;—Rev. Dr. Donaldson, on two unsolved Problems in Indo-German Philology;—Dr. T. Williams, Report on the British Annelida;—R. Mallet, Second Report on the Facts of Earthquake Phænomena;—Letter from Prof. Henry, to Col. Sabine, on the System of Meteorological Observations proposed to be established in the United States;—Col. Sabine, Report on the Kew Magnetographs;—J. Welsh, Report on the Performance of his three Magnetographs during the Experimental Trial at the Kew Observatory;—F. Ronalds, Report concerning the Observatory of the British Association at Kew, from September 12, 1850, to July 31, 1851;—Ordnance Survey of Scotland.

Together with the Transactions of the Sections, Professor Airy's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWENTY-SECOND MEETING, at Belfast, 1852, *Published at* 15*s*.

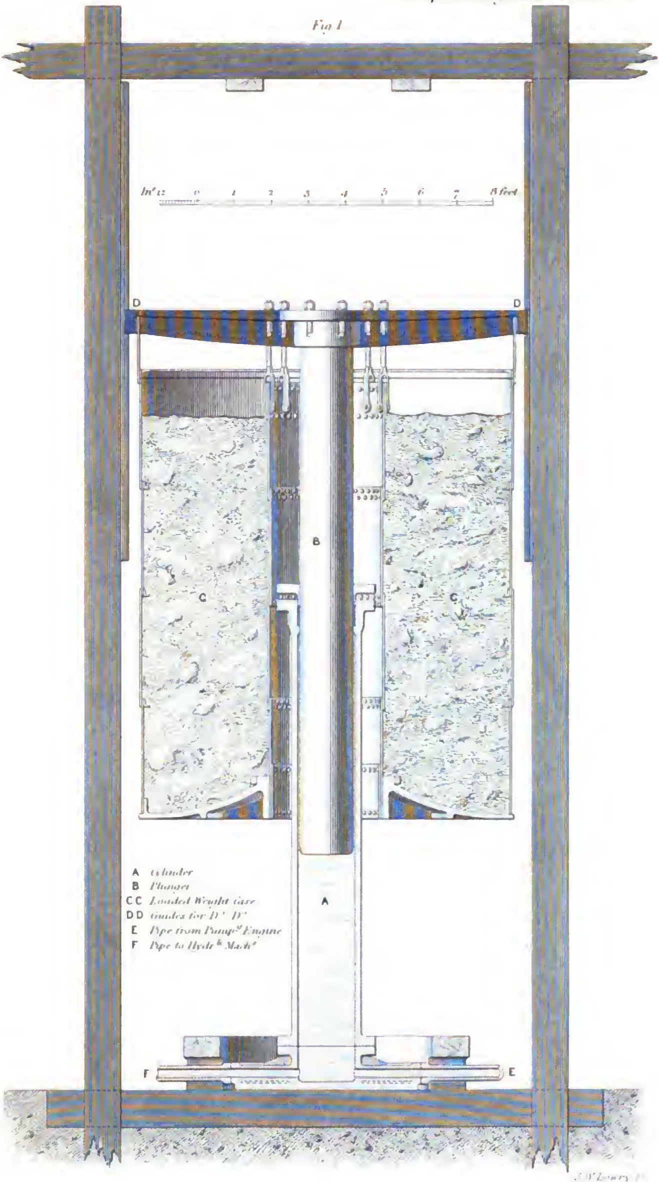
Contents:—R. Mallet, Third Report on the Facts of Earthquake Phænomena;—Twelfth Report of Committee on Experiments on the Growth and Vitality of Seeds;—Rev. Prof. Powell, Report on Observations of Luminous Meteors, 1851–52;—Dr. Gladstone, on the Influence of the Solar Radiations on the Vital Powers of Plants;—A Manual of Ethnological Inquiry;—Col. Sykes, Mean Temperature of the Day, and Monthly Fall of Rain, at 127 Stations under the Bengal Presidency;—Prof. J. D. Forbes, on Experiments on the Laws of the Conduction of Heat;—R. Hunt, on the Chemical Action of the Solar Radiations;—Dr. Hodges, on the Composition and Œconomy of the Flax Plant;—W. Thompson, on the Freshwater Fishes of Ulster;—W. Thompson, Supplementary Report on the Fauna of Ireland;—W. Wills, on the Meteorology of Birmingham;—J. Thomson, on the Vortex-Water-Wheel;—J. B. Lawes and Dr. Gilbert, on the Composition of Foods in relation to Respiration and the Feeding of Animals.

Together with the Transactions of the Sections, Colonel Sabine's Address, and Recommendations of the Association and its Committees.

PROCEEDINGS OF THE TWENTY-THIRD MEETING, at Hull, 1853, *Published at 10s. 6d.*

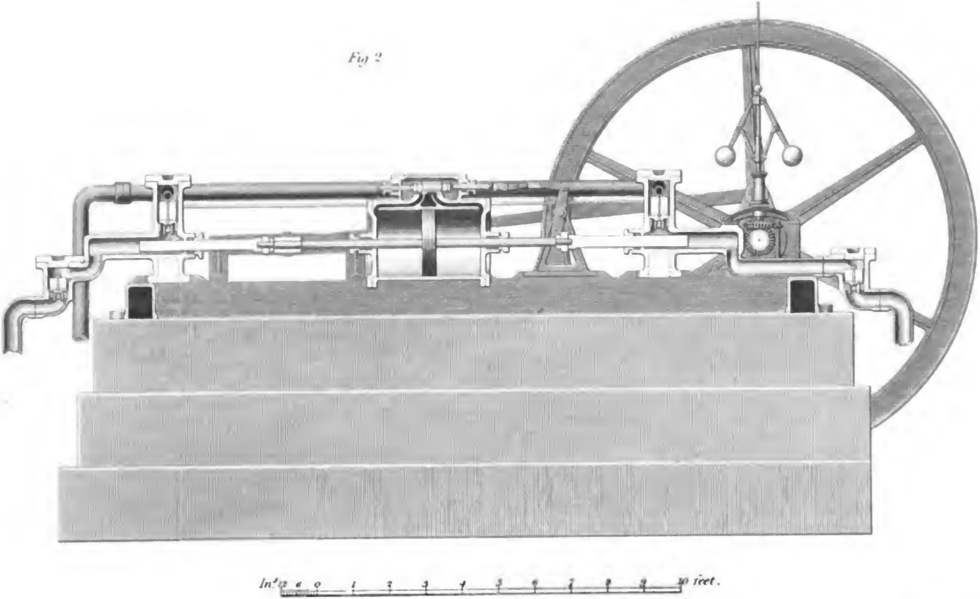
CONTENTS:—Rev. Prof. Powell, Report on Observations of Luminous Meteors, 1852–53;—James Oldham, on the Physical Features of the Humber;—James Oldham, on the Rise, Progress, and Present Position of Steam Navigation in Hull;—William Fairbairn, Experimental Researches to determine the Strength of Locomotive Boilers, and the causes which lead to Explosion;—J. J. Sylvester, Provisional Report on the Theory of Determinants;—Professor Hodges, M.D., Report on the Gases evolved in Steeping Flax, and on the Composition and Œconomy of the Flax Plant;—Thirteenth Report of Committee on Experiments on the Growth and Vitality of Seeds;—Robert Hunt, on the Chemical Action of the Solar Radiations;—John P. Bell, M.D., Observations on the Character and Measurements of Degradation of the Yorkshire Coast; First Report of Committee on the Physical Character of the Moon's Surface, as compared with that of the Earth;—R. Mallet, Provisional Report on Earthquake Wave-Transits; and on Seismometrical Instruments;—William Fairbairn, on the Mechanical Properties of Metals as derived from repeated Meltings, exhibiting the maximum point of strength and the causes of deterioration;—Robert Mallet, Third Report on the Facts of Earthquake Phænomena (concluded).

Fig. 1


In^s 12 0 1 2 3 4 5 6 7 8 feet
D
D
B
C
C
A
F
E
A Cylinder
B Plunger
CC Loaded Weight case
DD Guides for D' D'
E Pipe from Pump^g Engine
F Pipe to Hydr^{lc} Mach^e

J. W. Lowry fc.

Fig 2



J. W. Lowry sc.

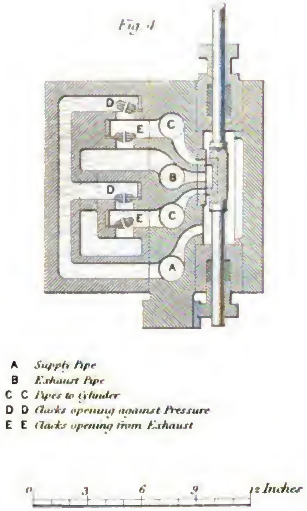


Fig. 4

A Supply Pipe
B Exhaust Pipe
C C Pipes to Cylinder
D D Clacks opening against Pressure
E E Clacks opening from Exhaust

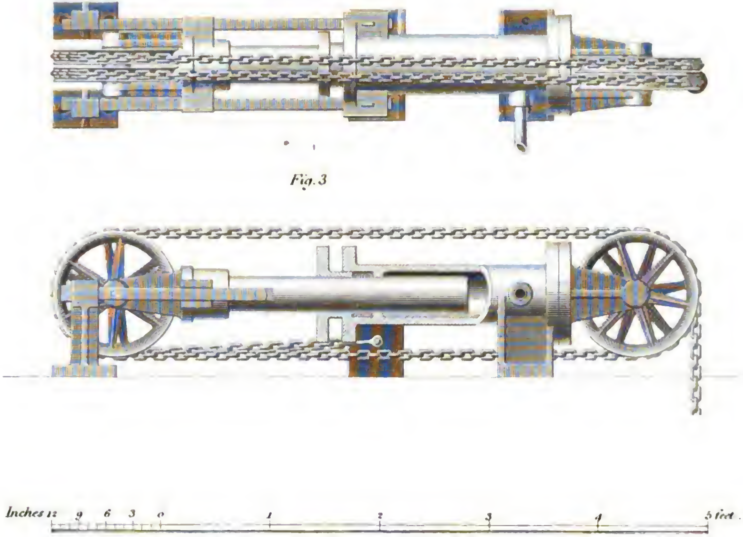
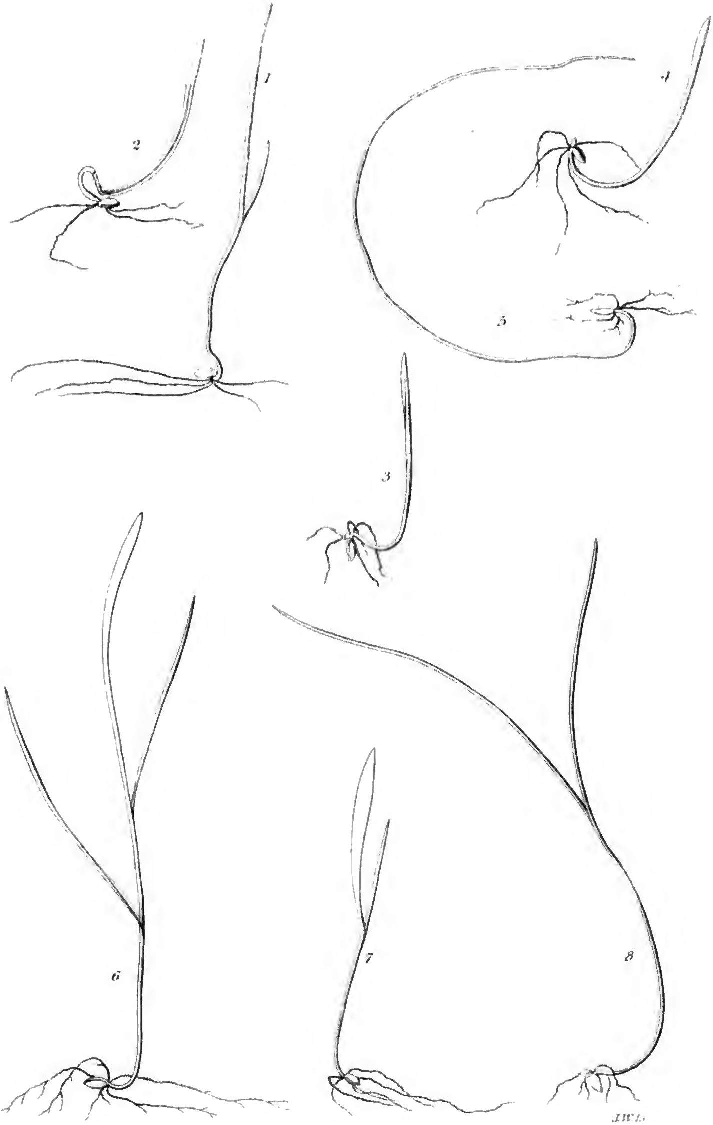


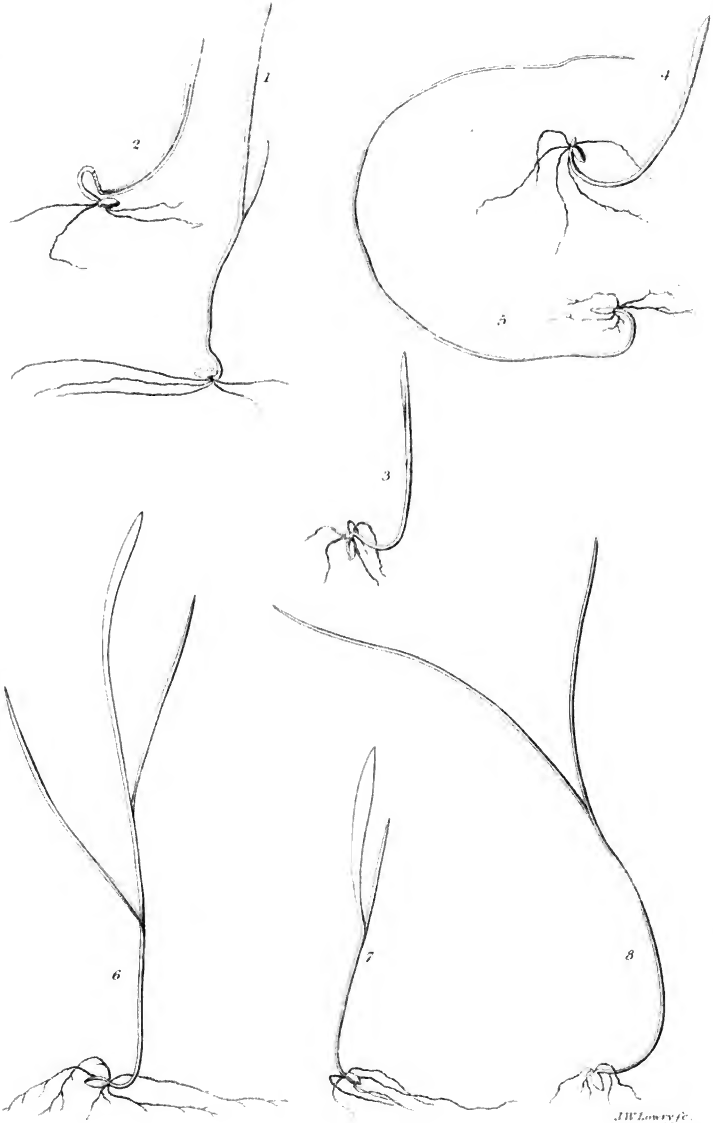
Fig. 3

J. W. Lowry sc.

24th Report Brit. Assoc 1854 PLATE IV.

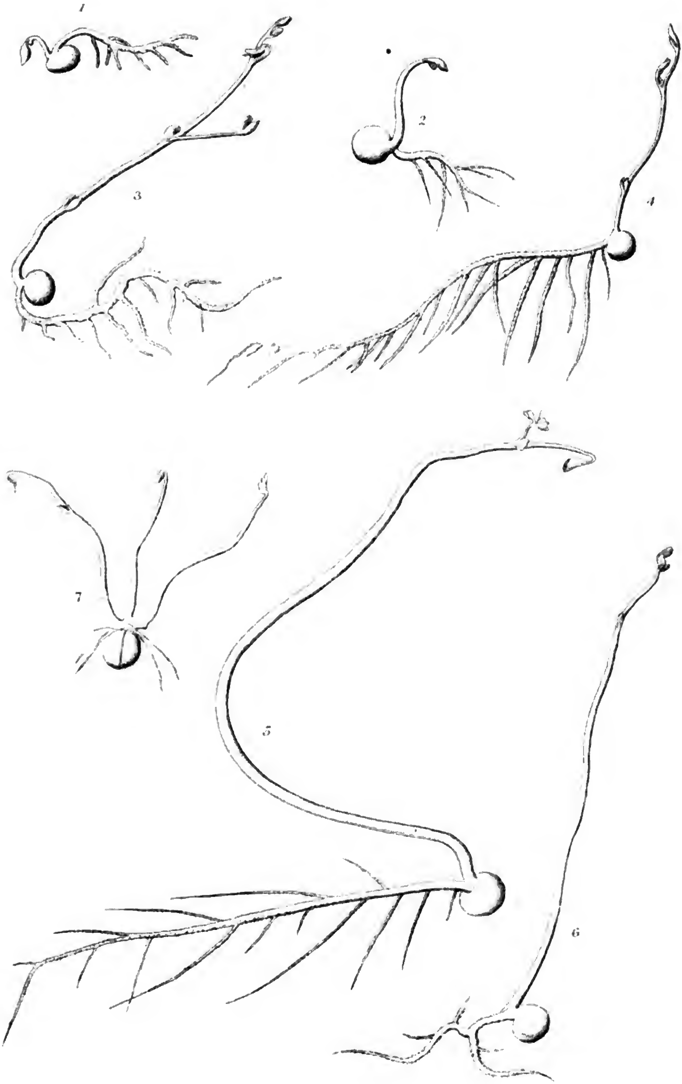


24th Report Brit. Assoc. 1854. PLATE IV.



J.W. Lowry fc.

24th Report Brit. Assoc. 1854. PLATE V.



J.W. Lowry fc.

ALBEMARLE STREET,

July, 1855.

MR. MURRAY'S LIST.

WORKS NOW READY.

A POPULAR EDITION OF

HALLAM'S HISTORICAL WORKS.

TO BE COMPLETED IN 10 MONTHLY VOLUMES.

This Edition has been undertaken from the urgent demands made upon the publisher, from time to time, for cheaper copies of these works, which have now become class books at the Universities and Public Schools, and it is hoped that the present mode of publication will place them within the means and reach of all classes of readers. The publication will commence on 1st May, and be published in the following order:—

EUROPE DURING THE MIDDLE AGES. 3 vols.
THE CONSTITUTIONAL HISTORY OF ENGLAND. 3 vols.
THE LITERARY HISTORY OF EUROPE. 4 vols.

Vols. I. and II. are published.

Post 8vo. 6*s*. each.

"A reputation continually growing for nearly forty years, and the steady sale of ten editions in an expensive form, prove that when time and labour conjoined with the requisite ability appear, the world will reward them better than the productions of more flashy or brilliant littérateurs. Fortified by this long-continued approbation of the more scholarly and critical classes, Mr. Murray has undertaken to present the historian of the Middle Ages in a popular form, and at a price, when all things are considered, about the cheapest of undertakings in this age of cheapness. A handsome volume of about five hundred pages, as full of typographical matter as is consistent with neatness of appearance and easy reading for the eyes, is to be had for six shillings. Three volumes will complete the 'Middle Ages'; ten the author's Historical Works; and each work may be purchased separately."—*Spectator*.

◆

HISTORY OF LATIN CHRISTIANITY.

INCLUDING THAT OF THE POPES TO THE PONTIFICATE OF NICHOLAS V.

BY HENRY HART MILMAN, D.D.,
Dean of St. Paul's.

First Portion. 3 Vols. 8vo. 36*s*.

THE SEA OF AZOF AND THE BLACK SEA.

WITH NARRATIVE OF TRAVELS IN THE CRIMEA, CIRCASSIA, AND BORDER PROVINCES;

AND NOTICES OF THE RESOURCES OF RUSSIA, MILITARY, NAVAL, AND COMMERCIAL IN THOSE COUNTRIES.

BY H. DANBY SEYMOUR, M.P.

With Map. 8vo. 12*s*.

"This is not exactly a book of travels, though an account of the author's own journeying and actual observations is interwoven with his deduced descriptions. It is a geographical, historical, statistical, and commercial compilation, drawn from various authorities; the best author for any particular district or subject being taken as a guide; information derived from other writers being likewise added; while the experience of Mr. Seymour, acquired during personal observation in 1844 and 1846, is used to test, animate, and enlarge the materials he draws from other sources."—*Spectator.*

◆

A TREATISE ON THE

AUGUSTINIAN DOCTRINE OF PREDESTINATION.

BY REV. J. B. MOZLEY, B.D.,

Fellow of Magdalen College, Oxford.

8vo. 14*s*.

"It is from a conviction of the profound ability, large knowledge, comprehensive reasoning, and, on the whole, irrefragable views, contained in Mr. Mozley's book, that we strongly recommend it to all persons who feel concernment in those lofty themes of thought and those sublime truths which, by the instincts of our nature, we continually aspire to, yet never fully apprehend.

"To the noble library of English ratiocination Mr. Mozley has contributed a volume which we believe will live with its finest specimens. His plummet has sounded the depths of controversies which have engaged the most luminous minds for ages, and he comes to the only conclusion concerning them which it is in the province of the human mind to form."—*The Press.*

"Mr. Mozley's Treatise on the Augustinian Doctrine of Predestination, a book of extraordinary power and clearness, and of excellent composition, well fitted to open the eyes of thousands, and to give a healthy and vigorous tone to the mind of any thinker who will master its contents."—*Literary Churchman.*

◆

HISTORICAL MEMORIALS OF CANTERBURY.

THE LANDING OF AUGUSTINE—THE MURDER OF BECKET—
THE BLACK PRINCE—BECKET'S SHRINE.

BY REV. ARTHUR P. STANLEY, M.A.

Second Edition. 8vo. 8*s*. 6*d*.

"The volume is a necessary handbook to the Cathedral, and will be found an acceptable guide to all who meditate a pilgrimage to Canterbury."—*Morning Post.*

THE EPISTLES OF ST. PAUL TO THE THESSALONIANS, GALATIANS, AND ROMANS.

WITH CRITICAL NOTES AND DISSERTATIONS.

BY REV. B. JOWETT, M.A.,

Fellow and Tutor of Balliol College, Oxford.

2 Vols. 8vo. 30*s*.

◆

THE EPISTLES OF ST. PAUL TO THE CORINTHIANS.

WITH CRITICAL NOTES AND DISSERTATIONS, &c.

BY REV. ARTHUR P. STANLEY, M.A.,

Chaplain to H.R.H. Prince Albert, and Canon of Canterbury Cathedral.

2 Vols. 8vo. 24*s*.

◆

POLYNESIAN MYTHOLOGY,

AND ANCIENT TRADITIONAL HISTORY OF THE NEW ZEALAND RACE, AS FURNISHED BY THEIR PRIESTS AND CHIEFS.

BY SIR GEORGE GREY,

Late Governor-in-Chief of New Zealand.

With Woodcuts. Post 8vo. 10*s*. 6*d*.

"The tales and legends which compose this volume were collected by Sir George Grey from chiefs and priests with whom he came in contact during his residence in New Zealand. The work affords honourable proof of the late Governor's conscientious and efficient conduct in his important office. The researches of which some of the fruits are presented in this volume were the result of an anxious desire to become familiar with the language and feelings of the people whom he had to govern. His own account of the manner in which his studies were directed will be read with much interest."—*Literary Gazette.*

"Sir George Grey deserves praise for having learned the language of the aborigines, and got acquainted with their traditions, in order the better to understand the people with whom he had to deal. The book does credit to his industry and sagacity. It is a useful contribution to the natural history of mankind."—*Economist.*

◆

HISTORY OF THE CHRISTIAN CHURCH.

TO THE PONTIFICATE OF GREGORY THE GREAT, A.D. 590.

BY REV. JAMES C. ROBERTSON, M.A.,

Vicar of Bekesbourne.

8vo. 12*s*.

A NEW LATIN-ENGLISH DICTIONARY.

BASED ON THE WORKS OF FORCELLINI AND FREUND.

BY WILLIAM SMITH, LL.D.,

Classical Examiner in the University of London, and Editor of the Dictionaries of "Greek and Roman Antiquities."

One Volume. Medium 8vo. 21*s.*

"Dr. Smith is a skilful and careful editor, not a mere translator. No better illustration of the nature of his labours can be imagined than is supplied by the contrast between this dictionary and that of Dr. Andrews. Both are in a great measure based upon the same authorities; but the one is an indifferent translation, edited in a slovenly style—the other is as free from imperfections of any kind as a book may be made by superior editorship and careful revision. * * *

"Passing from the etymological department, in which Dr. Smith's Dictionary stands quite alone, we find its superiority in other points equally decided, though this may not be so striking to a casual observer. The interpretation of words is conducted with the same editorial ability as the investigation of their etymology, combining accuracy of definition with excellence of arrangement, and completeness in the exhibition and illustration of the various shades of meaning, with a freedom from needless distinction and redundancy of detail. After stating in clear and precise language the radical notion attached to the word in question, the editor traces out all the derived meanings in the natural order of their development, giving, under each, instances of their occurrence in Latin authors. * * *

"Dr. Smith's Dictionary is a worthy companion to the works he has edited; and we have no doubt it will be even more extensively used than they, because its bulk and price are such as to render it more accessible. In point of cheapness, as well as more essential qualities, it has the advantage of all other Latin Dictionaries."—*Athenæum.*

"This Latin-English Dictionary is based upon the elaborate work of Forcellini, originally published at Padua in 1771, and Freund's German edition. Reference has been continually had to the American translation of Freund, poor as that book turns out to be in many points; and Dr. Smith has had recourse to other sources of information, as well as to his own knowledge. The result is an unrivalled book for the position it is intended to fill,—that is, a middle place between the extensive work of Forcellini or his translators, and the school dictionaries."—*Spectator.*

"Before we look into the quality of this Latin-English dictionary, we find ourselves testing it mechanically as a printed book, in wonder at its price. For there are upwards of twelve hundred pages in it, and on each page there are three columns of small and very perfect type, various in form, and admirably printed—its cost not many years ago must surely have been at least double the guinea now charged for it.

"But wonder of this kind is trebled when we come to test the literary value of the work.

"Dr. Smith's 'Latin-English Dictionary' contains very much that is not to be found either in Forcellini or in Freund, while it is lifted by its independent merit, and its incomparably greater fulness, far above comparison with any school or college dictionary commonly in use. Practically, it is the best that a man can have who keeps on his shelf one Latin-English dictionary as his oracle."—*Examiner.*

"An examination of this Dictionary has convinced us that we were not mistaken in our estimate of Dr. Smith's care and zeal in the performance of the work he had taken in hand. Of his ability to execute it well he had given abundant proofs, and the result is that he has produced a dictionary which, it is very limited praise to say, is very much superior to any we before possessed.

"The quantity as well as the quality of the information given by Dr. Smith is such as to leave all other Latin dictionaries which we have seen far behind. The arrangement by which the various meanings of a word are given, and illustrated by quotations from later authors following *immediately*, instead of the old-fashioned plan of using figures of reference for the illustrations, is calculated to save a great amount of trouble and time.

"Great credit is due for the manner in which the work is got up. The paper is good, the print, though small, is beautiful and clear, and, though extending to 1200 pages, the price is only one guinea."—*English Churchman.*

A SMALLER LATIN-ENGLISH DICTIONARY.

Abridged from the larger work for the Use of Junior Classes.

BY WILLIAM SMITH, LL.D.

Crown 8vo. 7*s.* 6*d.*

"Dr. Smith's 'Smaller Latin-English Dictionary' is designed for the use of the younger classes in schools. Its two great features are the order of exhibiting the meaning of words, which shows first the primitive and then the figurative sense, sufficiently illustrated by comment and quotation of authorities; and the manner in which the pupil's attention is directed to the use of etymology. In form it is like the common Entick's; in system, completeness, and all the comprehensiveness and refinements of modern scholarship, it far surpasses that very useful book."—*Spectator.*

"As a school dictionary, this abridgment of Dr. Smith's great work must rank as the best extant. It has two peculiar claims to favour. In the first place, every word is given which the youthful scholar is likely to meet with in the course of his classic reading; and in the second place, the various meanings and uses of words are given in detail, so that the student may select that signification most appropriate to the sense of the passage in which a particular word occurs. One authority, at least, is given for every word in the book, and in the case of important terms many authors are quoted to illustrate different significations. The typography and general plan are those of the larger work; and, in addition, there is a tolerably copious list of proper names. For elementary scholastic purposes, the dictionary is all that could be desired."—*Press.*

"Not long ago we called attention to the Latin-English Dictionary of Dr. William Smith. A smaller dictionary has now been prepared from it, which preserves most of its good features, indeed all of them that can be of any use in schools, or are required by ordinary readers of the Latin classics. It will take the same rank among small lexicons which is held by its elder brother among chiefs of the race, and is undoubtedly the best cheap dictionary that can be desired for common use."—*Examiner.*

"With that strong practical instinct for which Dr. Wm. Smith is remarkable he has here adapted his recently-published 'Latin-English Dictionary' to school purposes. The abridgment, which has been made under his superintendence, contains all that portion of the larger work which is required for the study of the classical authors read in schools, and retains all the characteristic excellencies of that work—its clearness and correctness of explanation, simplicity of arrangement, sufficiency of illustration, exhibition of etymological affinities and modern derivatives, and careful accuracy of typography. At the same time, by omitting words not likely to be wanted by those for whom the book is intended, the editor has been enabled to give all requisite information within a moderate compass. The remarks in the Preface on the difficulties experienced by young persons in the choice of suitable meanings, and the desirableness of devoting some time to an explanation of the proper mode of using a dictionary, are evidently written by a practical teacher, and deserve the attention of all whose duty it is to instruct beginners in Latin."—*Athenæum.*

◆

JOHNSON'S LIVES OF THE ENGLISH POETS.

EDITED, WITH NOTES,

BY PETER CUNNINGHAM, F.S.A.

3 vols. 8vo. 7*s.* 6*d.* each. (MURRAY'S BRITISH CLASSICS.)

◆

GOLDSMITH'S MISCELLANEOUS WORKS.

EDITED, WITH NOTES,

BY PETER CUNNINGHAM, F.S.A.

4 vols. 8vo. 7*s.* 6*d.* each. (MURRAY'S BRITISH CLASSICS.)

GIBBON'S ROMAN EMPIRE.

PRECEDED BY GIBBON'S AUTOBIOGRAPHY, AND EDITED, WITH NOTES,

BY WILLIAM SMITH, LL.D.,

Classical Examiner in the University of London.

Portrait and Maps. 8 vols. 8vo. 7*s*. 6*d*. each. (MURRAY'S BRITISH CLASSICS.)

"It is at least half a century too late to review the 'Decline and Fall of the Roman Empire.' By the consent of all qualified judges it stands the greatest history in the English language; a history scarcely to be equalled in any language; a work, as the most competent of critics, Niebuhr, pronounced it, 'never to be excelled.' On such a book it would ill become us to speak either in praise or censure. Its merits are admitted; its faults are known; it has taken its place.

"Of such a work all that we at this time of day can desire is a really good edition. And such to the fullest extent is that just completed and now before us. As the 'Decline and Fall' is the best history in the language, so is this the best edition of it. Hardly indeed would it be too much to say that it is one of the very best editions—for all practical and useful purposes, the best, of course not the most splendid—of any modern English classic."—*Chas. Knight's Paper.*

"Dr. W. Smith's edition of Milman's 'Gibbon' in Murray's British Classics, is brought to a worthy close with a noble index of a hundred and fifty pages in length. This book, as remarkable for its cheapness as its excellence, is now the one standard edition of Gibbon, and is likely long to remain so."—*Examiner.*

◆

THE ENGLISH BATTLES AND SIEGES OF THE PENINSULAR WAR.

BY LIEUT.-GEN. SIR WILLIAM NAPIER, K.C.B.

With Portrait. Post 8vo. 10*s*. 6*d*.

"Such a volume, filled with details of heroism and fortitude to which the annals of antiquity afford nothing superior, appears with wonderful opportuneness at such a time as the present, and may count, we suppose, on a wide popularity."—*Examiner.*

"Napier's 'History of the Peninsular War' has long been the text-book on that subject. In this volume Lieut.-General Napier has entirely recomposed the accounts of the combats of Roliça, Vimeiro, and Corunna; the other battles and sieges are, with more or less compression of details, transcripts from his 'History.' We need say nothing in their recommendation, the name of Napier 'recommends itself;' but we may add our conviction, that the work will be eagerly sought after as an authentic record of deeds of daring heroism as dintinguished as any that grace the British annals."—*Naval and Military Gazette.*

"A handsome and portable volume, giving the pith of the larger and unrivalled work of the gallant author. It is a well-timed publication, and will be a very convenient and suitable present to the junior candidates for military honours. It has a highly characteristic portrait of Sir William Napier."—*English Churchman.*

"Sir William Napier has extracted from his great work some of its most brilliant and delightful passages, and combined them into one volume. It is done, we need hardly say, with great judgment, and will for the common run of readers supply the place of his large History, which most men have neither money to purchase nor time to read."—*Guardian.*

"A handsome and handy volume, of deep interest and timely appearance, as serving to bring before the mind's eye the great battles of nearly half a century ago. In extracting the "Battles and Sieges" from the History of the Peninsular War, they have been revised, and Roriça, Vimiera, and Corunna recomposed."—*Spectator.*

A MANUAL OF ELEMENTARY GEOLOGY;

OR, THE ANCIENT CHANGES OF THE EARTH AND ITS INHABITANTS, ILLUSTRATED BY ITS GEOLOGICAL MONUMENTS.

BY SIR CHARLES LYELL, F.R.S.

Fifth Edition, thoroughly revised, with 750 Woodcuts. 8vo. 14*s.*

"Sir Charles Lyell continues to follow up his geological investigations with such unremitting vigour, that the additions to his noble philosophic treatises carry the importance of new works.

"More than three years have passed since the last edition of the Manual of Geology was published. During that interval many new facts have been ascertained, and important subjects have undergone thorough discussion.

"The additional matter in this edition amounts to about a hundred and forty closely printed pages, and two hundred new illustrations are also given, the volume containing in all about seven hundred and fifty wood-cuts. The work is now more than ever worthy of being regarded as a standard manual of elementary geology."—*Literary Gazette.*

◆

HIMALAYAN JOURNALS;

OR, NOTES OF A NATURALIST, IN BENGAL, SIKHIM, NEPAL, HIMALAYAS MOUNTAINS, &c.

BY JOSEPH DALTON HOOKER, F.R.S.

With many Woodcuts. 2 Vols. 8vo. 36*s.*

◆

THE ORIGIN AND PROGRESS OF THE

MECHANICAL INVENTIONS OF JAMES WATT.

ILLUSTRATED FROM HIS CORRESPONDENCE WITH HIS FRIENDS, AND A SPECIFICATION OF HIS PATENTS, WITH AN INTRODUCTORY MEMOIR.

BY JAMES P. MUIRHEAD, ESQ., M.A.

With Portrait and Plates. 3 Vols. 8vo. 45*s.*—Larger paper, 4to. 84*s.*

◆

HISTORY OF THE ENGLISH POOR LAW

IN CONNECTION WITH THE CONDITION OF THE PEOPLE.

BY SIR GEORGE NICHOLLS, K.C.B.,

Late Poor Law Commissioner and Secretary to the Poor Law Board.

2 Vols. 8vo. 28*s.*

THE LIFE AND MISCELLANEOUS WORKS OF THOMAS YOUNG, M.D.

WITH SELECTIONS FROM HIS CORRESPONDENCE.

EDITED BY DEAN PEACOCK AND JOHN LEITCH, ESQ.

With Portrait and Plates. 4 Vols. 8vo. 15*s.* each.

"The republication of Dr. Young's works, and this memoir by Dean Peacock, clear in statement and masterly in style, will secure tardy justice to the memory of a philosopher whose claims will not henceforth be disputed to two of the greatest achievements of modern science—the establishment of the undulatory theory of light, and the interpretation of the hieroglyphics of Egypt.

"The Memoir by Dean Peacock is extremely interesting as a biography, while it gives lucid and condensed information on the various subjects with which Dr. Young's name is associated. Mr. Leitch has ably fulfilled his share of the work, in editing the hieroglyphic papers and correspondence."—*Literary Gazette.*

"Dr. Peacock's *Life of Young* is the result of an undertaking 'rashly' made more than twenty years ago; but of which ill-health or pressing avocations have suspended the execution till now. Extensive stores of correspondence and family papers have been placed in the biographer's hands. He is well qualified for giving an account of Young's scientific labours, and fixing his position as a philosopher. Both the career of the man and the discoveries of the scholar and natural philosopher are clearly told. When the mass of Dr. Young's journals, correspondence, and so forth, is considered, Dr. Peacock is entitled to the credit of having exercised a rare discretion in their sparing use."—*Spectator.*

◆

MAXIMS AND HINTS ON ANGLING.

WITH THE MISERIES OF FISHING.

BY RICHARD PENN, ESQ.

New Edition. Woodcuts. Fcap. 8vo. 1*s.* (MURRAY'S RAILWAY READING).

◆

KNOWLEDGE IS POWER;

A VIEW OF THE PRODUCTIVE FORCES OF MODERN SOCIETY, AND THE RESULTS OF LABOUR, CAPITAL, AND SKILL,

BY CHARLES KNIGHT,

With Woodcuts, Crown 8vo, 7*s.* 6*d.*

"We know no better work we could recommend to a beginner in the science of political economy than this. It is now generally admitted that a knowledge of the first principles of this science ought to be instilled into the popular mind even in training schools; and yet, sooth to say, most writers on the subject have mystified and obscured its elements by the air of abstraction they have communicated to them. Mr. Knight, at least, has avoided this failing. His work may well be called philosophy teaching by example. The most familiar operations in common life are seized upon and brought forward to illustrate some important principle, and that so happily, so pleasantly, and with such adaptation to the mind of the reader, that the judgment is enlightened while the fancy is entertained, and the reader finds that he has mastered a principle while reading a story. The volume is illustrated with a number of wood-cuts, which show in strong contrast the tedious operation and the cumbrous implements of former times along with the rapid processes and the stupendous machinery of modern days."—*Morning Chronicle.*

HANDBOOK OF PAINTING.

THE ITALIAN SCHOOLS.

TRANSLATED FROM THE GERMAN OF KUGLER. EDITED, WITH NOTES,

BY SIR CHARLES EASTLAKE, P.R.A.

Third Edition. With 150 Illustrations of the most famous pictures. 2 Vols. Crown 8vo. 30s.

"In its present shape the work is complete as far as it extends; the progress of Italian painting is traced from the age of Constantine to its decline in the seventeenth century, with great knowledge and discrimination; and the characteristics of each master are happily seized, and distinctly and forcibly expressed. It is this combination of historic lore with artistic feeling that has made Kugler's book popular through Europe. He feels the peculiar merits of each master he notices, and hence is enabled by a few descriptive touches to express the character of his greatest works and give a true idea of his genius. Fuller details on particular points may be contained in other works, but in none is there found so firm a grasp of the whole subject, or such fine appreciation of artistic qualities and beauties. For this reason the work will be valued by all who desire to know not only the leading facts of the history of the Italian school, but its peculiar excellencies; to comprehend not only its forms, but its spirit.

"Apart from the judicious translation of Kugler's text, the careful notes of our accomplished President of the Royal Academy, and the elegant style in which this handbook is produced, the numerous illustrations would alone give substantial value to the work. The merit of that quality of art known as *composition* can only be illustrated by example, and the criticism on a picture is always better understood when a drawing from it, on however small a scale, is before the eye."—*The Press.*

"And while mentioning new editions we remark without surprise the early appearance of Sir Charles Eastlake's *Handbook of the Italian Schools.* The basis of this work, as our readers know, is German, but the notes of its accomplished editor have given it an independent original character, and a value it could have derived from no other English source. Here and there we see additional notes; and the minute but careful outlines of the great Italian pictures, more than a hundred in number and marvellously executed by Mr. Scharf, have lost none of their sharpness and brilliancy."—*Examiner.*

◆

HANDBOOK FOR YOUNG PAINTERS.

BY CHARLES ROBERT LESLIE, R.A.,

Author of "Life of Constable."

With Illustrations. Post 8vo. 10s. 6d.

"Lectures delivered by the author at the Royal Academy form the nucleus of this volume. Mr. Leslie declares in his preface that he is driven to write, not because no previous writers on Art have existed, but because too many have already lived, and too much has been written. He is not afraid, he says sarcastically, at the present day, of want of patronage for Art, but of want of Art to patronise. The discovery of his own errors entitles him, he thinks, to expose the errors of others; the discovery, he ingenuously says, made too late to benefit himself, may be soon enough to be of use to others. He does not, however, under the modest title of 'A Handbook,' address students alone, but matured painters and the whole world of general purchasers."—*Athenæum.*

TREASURES OF ART IN GREAT BRITAIN.

BEING AN ACCOUNT OF THE CHIEF COLLECTIONS OF PAINTINGS, DRAWINGS SCULPTURES, MINIATURES, MSS., &c., IN THIS COUNTRY.

BY DR. WAAGEN,

Director of the Royal Gallery of Pictures at Berlin.

With Index. 3 Vols. 8vo. 36*s.*

◆

A DICTIONARY OF ITALIAN PAINTERS.

WITH A TABLE OF CONTEMPORARY SCHOOLS.

BY A LADY. EDITED BY RALPH N. WORNUM.

Post 8vo. 6*s.* 6*d.*

"A brief but very compact and well arranged 'Biographical Catalogue of the Principal Italian Painters,' put together by Mrs. Farquhar, and edited by Mr. Wornum. It comprises short intelligent notices of the life and works of each artist, and prefixed to it is a very useful Tabular View of the schools of Italian painting."—*Examiner.*

◆

THE MONASTERY AND MOUNTAIN CHURCH.

A STORY-BOOK FOR CHILDREN.

BY THE AUTHOR OF "SUNLIGHT THROUGH THE MIST."

With Woodcuts. 16mo. 4*s.*

◆

THE CRIMEA AND ODESSA;

THE CLIMATE AND RESOURCES, DESCRIBED FROM PERSONAL KNOWLEDGE,

BY PROFESSOR KOCH.

Map. Post 8vo. 10*s.* 6*d.*

"Dr. Koch is not a traveller who gives us merely a flimsy account of his own sayings and doings,—of what he saw and felt in foreign parts, or what he fancied,—leaving us on all material points as much in the dark as ever. He exhausts his subject with German patience and diligence. He goes into the most minute points of history,—and he compresses the labours of all the best-informed writers on the subject of which he treats into every one of his pregnant and truthful chapters. The reader must not, indeed, expect mere light fancies and sparkling thoughts in Dr. Koch's pages;—he must read them carefully as a serious study; and he may always fearlessly refer to them as a respectable authority on disputed points,—a dictionary of curious and interesting facts."—*Athenæum.*

HANDBOOK FOR TRAVELLERS IN SPAIN.

ARRANGED AS A WINTER OR SUMMER TOUR.

BY RICHARD FORD, ESQ.

PART I. A WINTER TOUR.—ANDALUCIA, RONDA, GRANADA, MURCIA, VALENCIA, AND CATALONIA. THE PORTIONS BEST SUITED FOR THE INVALID AND A WINTER TOUR.

PART II. A SUMMER TOUR.—ESTREMADURA, LEON, GALLICIA, THE ASTURIAS, THE CASTILLES (OLD AND NEW), THE BASQUE PROVINCES, NAVARRE, AND ARRAGON. A SUMMER TOUR.

Third and Revised Edition. With Map. 2 Vols. Post 8vo.

◆

THE ENGLISHWOMAN IN RUSSIA;

OR, IMPRESSIONS OF MANNERS AND SOCIETY DURING A TEN YEARS' RESIDENCE IN THAT COUNTRY.

Fifth Thousand. With Woodcuts. Post 8vo. 10*s.* 6*d.*

◆

HANDBOOK TO THE ART OF TRAVEL;

OR, HINTS AND SUGGESTIONS AVAILABLE IN WILD COUNTRIES.

BY FRANCIS GALTON,

Author of "The Narrative of an Explorer in Tropical South Africa."

Woodcuts. Post 8vo. 6*s.*

"Mr. Galton, who had written a very good book about his explorations in Tropical South Africa, now publishes this little volume for the use of emigrants, soldiers, and the more adventurous class of tourists who 'go in for camels,' savages, and lions,—for all in fact who travel far and 'rough it.'—which touches upon most of the points to which such a traveller would thank a book for calling his attention, and is no doubt competent also to put some useful ideas into the heads of the men who stay at home."—*Examiner.*

"The author has collected with singular research a series of recipes for the alleviation of every imaginable difficulty that can beset a man in the wilderness. These are partly the results of his own experiences in his explorations of tropical South Africa, and partly gathered from the works of other travellers, sportsmen, and missionaries. As far as our own experience will guide us in judging of Mr. Galton's 'shifts and contrivances"—and we have had the fortune or misfortune to be obliged personally to test many of them—we can strongly commend them."—*Leader.*

◆

HOSPITALS AND SISTERHOODS.

SUGGESTIONS FOR THE ELEVATION AND IMPROVEMENT OF THE CLASS OF NURSES.

Second Edition, Fcap. 8vo. 3*s.* 6*d.*

THE
TRUE PRINCIPLES OF SUNDAY LEGISLATION.

Foolscap 8vo.

JOURNAL OF THE ROYAL AGRICULTURAL SOCIETY OF ENGLAND.

Vol. 16. Part 1.

CONTENTS.

Lameness in Sheep and Lambs.
Hereditary Diseases of Sheep and Pigs.
Experiments on Fattening Sheep.
Experiments made with Manures for Turnip Crop.
Artificial Manures for Swedes.
On Autumn Cleaning of Stubbles.
The Use of the Aneroid Barometer.
Agricultural Relations of the Hampshire Tertiary District, and the Marls of the New Forest.
Remarks on Continental Farming.
On Feeding Cattle on Turnips.
The Fertility or Barrenness of Soils.
The Growth of Wheat at Holkham Park Farm.
On Breeds of Sheep in Great Britain, with reference to their Wool.
The Atmosphere as a Source of Nitrogen to Plants.

8vo.

LIFE OF GENERAL WASHINGTON.
BY WASHINGTON IRVING.

Vol. I. Post 8vo. 2*s.* 6*d.*

THOUGHTS ON NATIONAL EDUCATION.
BY LORD LYTTELTON.

8vo. 1*s.*

SKETCHES OF PARIS.
BY SIR FRANCIS B. HEAD, BART.

BEING A NEW AND CHEAPER EDITION OF A "FAGGOT OF FRENCH STICKS."

Two Vols. Post 8vo. 12*s.*

Albemarle Street,
July, 1855.

MR. MURRAY'S LIST.

WORKS IN PREPARATION.

◆

History of England and France under the House of Lancaster.

WITH AN INTRODUCTORY VIEW OF THE EARLY REFORMATION.

BY HENRY LORD BROUGHAM.

SECOND EDITION. 8vo. [*Next Week.*

A History of Rome.

FROM THE EARLIEST TIMES TO THE ESTABLISHMENT OF THE EMPIRE.

BY THE VERY REV. HENRY G. LIDDELL, D.D.,
Dean of Christ Church, Oxford.

Library Edition. 2 Vols. 8vo.

The Works of Alexander Pope.

WITH AN ORIGINAL LIFE, INCLUDING NEARLY 400 NEW LETTERS.

EDITED BY THE RIGHT HON. JOHN WILSON CROKER.

ASSISTED BY PETER CUNNINGHAM, F.S.A.

Portraits. 8 Vols. 8vo.

(MURRAY'S BRITISH CLASSICS.)

⁂ This edition will contain the unpublished correspondence of Pope with Edward Earl of Oxford, with Broome, his assistant in the translation of the Odyssey; Dr. Arbuthnot, Lord Bathurst, Mallet, Fenton, &c. It will be collated, for the first time, with all the editions which appeared in the Poet's lifetime, which are of far greater authority than those of Warburton, Warton, and Roscoe. The allusions throughout to persons and events will be explained with greater fulness and accuracy than has yet been attempted. The Life will contain many new facts of importance, and correct many errors of previous biographers.

ESSAYS ON THE

Early Period of the French Revolution.

ORIGINALLY CONTRIBUTED TO THE QUARTERLY REVIEW. COLLECTED AND ARRANGED

BY THE RIGHT HON. JOHN WILSON CROKER.

8vo.

The Confidential Correspondence of Napoleon Buonaparte

WITH HIS BROTHER JOSEPH, SOMETIME KING OF SPAIN.

SELECTED AND TRANSLATED, WITH EXPLANATORY NOTES, FROM THE "MÉMOIRES DU ROI JOSEPH."

2 Vols. 8vo.

*** By an arrangement with M. de Casse, the French editor, Mr. Murray has secured the exclusive right of translating this very remarkable work into English.

Caravan Journeys and Wanderings

IN PERSIA, AFFGHANISTAN, TURKISTAN, AND BELOOCHISTAN,

WITH HISTORICAL NOTICES OF THOSE COUNTRIES, DESCRIPTIONS OF THE CITIES OF MESHED, HERAT, BALK AND CANDAHAR, AND SKETCHES OF THE NOMAD TRIBES OF CENTRAL ASIA.

BY J. P. FERRIER,

Formerly of the 1st Regiment of Chasseurs d'Afrique, and for several years Adjutant General in the Military Service of Persia.

TRANSLATED FROM THE ORIGINAL MANUSCRIPT

BY CAPT. WILLIAM JESSE,

Author of "Russia and the War."

With Map. 8vo.

General Ferrier resided for ten years in Persia, and was perfectly acquainted with the language, policy, and customs of that country. Obliged to leave it in 1842, in consequence of the intrigues of the Russian Government, he sought the protection and support of his own, which not having obtained, he returned to the East and resided eighteen months at Bagdad. Thence he commenced the journey of which this work contains the narrative, intending to reach Lahore by Herat and Candahar. Failing however in this attempt, he made several excursions in these and other parts of Central Asia. Being in an Oriental disguise, and travelling entirely in the company of natives only, he had opportunities of acquiring a knowledge of the habits and opinions of the people with whom he came in contact, such as few Europeans have enjoyed. General Ferrier appears to have been a shrewd observer, and has carefully noted down the principal geographical features and natural productions of the countries lying between Russia and India through which he passed. His interviews with Yar Mohammed of Herat, the Chief of Candahar, and other characters who may yet play an important part in the Politics of Central Asia, and the many adventures and sufferings which he encountered in his Travels, are highly interesting.

Hume's History of England.

A NEW EDITION, CAREFULLY REVISED THROUGHOUT,

WITH NOTES AND COMMENTS TO CORRECT HIS ERRORS AND SUPPLY HIS DEFICIENCIES.

8vo.

(MURRAY'S BRITISH CLASSICS.)

"When a young man of eighteen asks for a History of England there is no resource but to give him Hume. David Hume is the master of the field. There is not a page of his that we could not correct and amplify, nevertheless we cannot do without him, we have not the resolution nor, we may add, the genius to supply a substitute. On the whole we expect to see no rival to Hume in our times."—*Times, October 28th.*

History of Latin Christianity,

INCLUDING THAT OF THE POPES TO THE PONTIFICATE OF NICHOLAS V.

BY THE VERY REV. HENRY HART MILMAN,
Dean of St. Paul's.

Vols. IV. to VI. With Index. Completing the Work. 8vo.

The War; its Miseries, Mercies, and Duties.

A SERMON FOR THE PRESENT TIME.

BY CHRISTOPHER BENSON, A.M.,
Canon of Worcester, and late Master of the Temple.

8vo. 1*s*. [*Ready.*

The Marble and Brick Architecture of the Middle Ages in Italy.

BEING THE NOTES OF A TOUR IN LOMBARDY, VENICE, &c.

BY GEORGE EDMUND STREET, ARCHT.

Illustrated with Plates and Woodcuts. 8vo. [*Ready.*

History of Greece.

CONTINUED TO THE DEATH OF ALEXANDER THE GREAT, WITH A REVIEW OF PLATO AND ARISTOTLE.

BY GEORGE GROTE, ESQ.

Vol XII. (completing the Work). With Portrait. 8vo.

⁂ A copious INDEX to the entire work is in preparation.

Coins of Ancient Lycia, before the Reign of Alexander.

WITH AN ESSAY ON THE RELATIVE DATES OF THE LYCIAN MONUMENTS IN THE BRITISH MUSEUM.

BY SIR CHARLES FELLOWS.

Plates. Imperial 8vo. 10s. 6d.

"A valuable contribution to numismatic lore, and to the archæology of ancient Lycia. The book consists of nineteen plates of coins which Sir Charles Fellows considers to have been ancient Lycian, though previously known as 'uncertain Cilician.' In some cases Sir Charles is himself doubtful; in others the proof is inferential. The classification to a great extent is inferential too: a certain district of Lycia abounded in wild boars; therefore coins with a boar's head probably emanated from that district; lions are said to be found in another locality, and a coin with a lion's scalp comes thence. As yet the question of these Lycian coins is only raised for discussion. If the coins of which fac-similes are given in this volume are all Lycian, and the chronology of Sir Charles is correct, Lycia must have early reached eminence in numismatic art, and minted a great number of coins, if not a very large amount of money."—*Athenæum.*

Colonial Constitutions.

AN OUTLINE OF THE CONSTITUTIONAL HISTORY AND EXISTING GOVERNMENT OF THE BRITISH DEPENDENCIES.

WITH THE ORDERS IN COUNCIL, STATUTES, AND PARLIAMENTARY DOCUMENTS RELATING TO EACH DEPENDENCY.

BY ARTHUR MILLS, ESQ.,

Of the Inner Temple, Barrister-at-Law.

8vo.

The Works of Dean Swift.

A NEW AND REVISED EDITION. EDITED WITH NOTES, AND PRECEDED BY A NEW LIFE.

9 Vols. 8vo.

(MURRAY'S BRITISH CLASSICS.)

Notes of Travels in Sinai and Palestine.

IN CONNEXION WITH THEIR HISTORY.

BY REV. ARTHUR P. STANLEY, M.A.,

Chaplain to H.R.H. the Prince Albert, and Canon of Canterbury.

With Maps. 8vo.

A Journey Through Albania,

AND OTHER PROVINCES OF TURKEY IN EUROPE AND ASIA, TO CONSTANTINOPLE, DURING THE YEARS 1809 AND 1810.

BY THE RIGHT HON. LORD BROUGHTON.

A New and Revised Edition. With Maps and Woodcuts. 2 Vols. 8vo.

Turkey and its Inhabitants.

THE MOSLEMS, GREEKS, ARMENIANS, &c.—THE REFORMED INSTITUTIONS, ARMY, &c., DESCRIBED.

BY M. A. UBICINI.

2 Vols. Post 8vo.

Foundation and Superstructure;

A SERMON PREACHED IN THE CHURCH OF NEW SHOREHAM, ON JULY 4, 1855, ON THE OCCASION OF LAYING THE FIRST STONE OF THE COLLEGE OF ST NICHOLAS, AT LANCING.

BY ARTHUR PENRHYN STANLEY, M.A.,

Canon of Canterbury Cathedral.

8vo.

Handbook for Travellers in India.

AN ACCOUNT OF THE THREE PRESIDENCIES, AND OF THE OVERLAND ROUTE

A GUIDE FOR TRAVELLERS, OFFICERS, AND CIVILIANS.

Map. Post 8vo.

The History of Herodotus.

A NEW ENGLISH VERSION. TRANSLATED FROM THE TEXT OF GAISFORD, AND EDITED

WITH COPIOUS NOTES AND APPENDICES, ILLUSTRATING THE HISTORY AND GEOGRAPHY OF HERODOTUS, FROM THE MOST RECENT SOURCES OF INFORMATION, EMBODYING THE CHIEF RESULTS, HISTORICAL AND ETHNOGRAPHICAL, WHICH HAVE BEEN OBTAINED IN THE PROGRESS OF CUNEIFORM AND HIEROGLYPHICAL DISCOVERY,

BY REV. GEORGE RAWLINSON, M.A.,
Exeter College, Oxford. Assisted

BY COL. RAWLINSON, C.B., AND SIR J. G. WILKINSON, F.R.S.

4 Vols. 8vo.

A SUPPLEMENTAL VOLUME TO

Treasures of Art in Great Britain.

INCLUDING NEARLY FORTY NEW GALLERIES AND CABINETS EXISTING IN LONDON AND THE PROVINCES, VISITED AND DESCRIBED IN 1854.

BY DR. WAAGEN.

8vo.

Handbook of the Arts of the Middle Ages and Renaissance Period.

INCLUDING

Sculpture in Stone.
Carving in Ivory and Wood.
Metal Work.
Painting in Oil.
On Glass.
Embroidery.
Enamels.
Goldsmiths' Work.
Pottery, Italian, French, and German.
Glass, Venetian, &c.
Armour.
Locksmiths' Work.
Clock and Watch-work.
Furniture, Ecclesiastical, Civic, and Domestic, &c.

TRANSLATED FROM THE FRENCH OF M. JULES LABARTE.

BY MRS. PALLISER.

200 Illustrations. 8vo.

The Historic Peerage of England.

EXHIBITING, UNDER ALPHABETICAL ARRANGEMENT, THE DATE OF CREATION, DESCENT, AND PRESENT STATE OF EVERY TITLE OF PEERAGE WHICH HAS EXISTED IN THIS COUNTRY SINCE THE CONQUEST.

BY THE LATE SIR NICOLAS HARRIS NICOLAS.

BEING A NEW EDITION OF "THE SYNOPSIS OF THE PEERAGE."

REVISED, CORRECTED, AND BROUGHT DOWN TO THE PRESENT TIME, INCLUDING ALL RECENT CREATIONS, EXTINCTIONS, DEATHS, &c.

BY WILLIAM COURTHOPE, ESQ.,
Somerset Herald.

8vo.

Biblical Researches in the Holy Land.

BY REV. EDWARD ROBINSON, D.D.

A New and Revised Edition. With Maps. 8vo.

Later Biblical Researches in the Holy Land in the Year 1852.

BY REV. EDWARD ROBINSON, D.D.

With Maps. 8vo.

Handbook of History and Chronology.

ALPHABETICALLY ARRANGED TO FACILITATE REFERENCE.

BY B. B. WOODWARD, B.A.

One Volume. 8vo.

Elucidation of the Laws of Copyright

IN BOOKS, MUSIC, DRAMATIC WRITINGS, PAINTINGS, ENGRAVINGS, MAPS, CHARTS, AND PLANS.

INCLUDING INTERNATIONAL COPYRIGHT, AND THE RIGHTS OF THE BRITISH MUSEUM AND OTHER PUBLIC LIBRARIES ENTITLED TO GRATUITOUS COPIES.

BY D. ROBERTON BLAINE, ESQ.
Barrister at Law, Author of "The Laws of Artistic Copyright and their Defects."

8vo.

Murray's Handbook for Paris.

With Plans. Post 8vo.

History of the Church in the Three First Centuries.

BEING THE SUBSTANCE OF LECTURES DELIVERED BEFORE THE UNIVERSITY OF CAMBRIDGE,

BY THE LATE REV. J. J. BLUNT,

While Margaret Professor of Divinity.

8vo.

Ancient Spanish Ballads,

HISTORICAL AND ROMANTIC. TRANSLATED, WITH NOTES,

BY J. G. LOCKHART, ESQ.

Fourth Illustrated Edition, with Woodcuts and Illuminations. 4to.

Illustrated Handbook of Architecture.

BEING A CONCISE AND POPULAR ACCOUNT OF THE DIFFERENT STYLES PREVAILING IN ALL AGES AND COUNTRIES OF THE WORLD.

BY JAMES FERGUSSON, ESQ.,

Author of "Palaces of Nineveh and Persepolis Restored."

With 1000 Illustrations on Wood. 8vo.

The Pilgrimage, and other Poems.

BY THE EARL OF ELLESMERE.

With Illustrations. 4to.

A Bird's-Eye View of India.

WITH EXTRACTS FROM A JOURNAL KEPT IN THE PROVINCES, NEPAUL, &c.

BY SIR ERSKINE PERRY, M.P.,

Late Chief-Justice of Bombay.

Fcap. 8vo.

BRADBURY AND EVANS, PRINTERS, WHITEFRIARS.

August 1855.

WORKS PUBLISHED
BY TAYLOR AND FRANCIS,

PRINTERS AND PUBLISHERS TO THE UNIVERSITY OF LONDON,

RED LION COURT, FLEET STREET.

Reports of the British Association for the Advancement of Science.

	Published price.	Price to Members.		Published Price.	Price to Members.
	s. d.	*s. d.*		*s. d.*	*s. d.*
For 1831–32...	13 6	9 0	For 1844	20 0	6 8
1833	12 0	8 0	1845	12 0	4 0
1834	15 0	5 0	1846	15 0	5 0
1835	13 6	4 6	1847	18 0	6 0
1836	12 0	4 0	1848	9 0	3 0
1837	16 6	5 6	1849	10 0	6 8
1838	15 0	5 0	1850	15 0	10 0
1839	*out of*	*print.*	1851	16 6	11 0
1840	15 0	10 0	1852	15 0	10 0
1841	13 6	4 6	1853	10 6	7 0
1842	10 6	3 6			
1843	12 0	4 0			

British Association Catalogue of Stars. 63s.

The Catalogue of Stars of the British Association for the Advancement of Science; containing the Mean Right Ascensions and North Polar Distances of Eight thousand three hundred and seventy-seven fixed Stars, reduced to January 1, 1850: together with their Annual Precessions, Secular Variations, and Proper Motions, as well as the Logarithmic Constants for computing Precession, Aberration and Nutation. By the late Francis Baily, Esq., D.C.L., &c.

Lalande's Catalogue of Stars. 21s.

A Catalogue of those Stars, (47,390) in the Histoire Céleste Française of Jérome Delalande.

Lacaille's Catalogue of Stars. 5s.

A Catalogue of 9766 Stars in the Southern Hemisphere, for the beginning of the year 1750, from the Observations of the Abbé de Lacaille, made at the Cape of Good Hope in the years 1751 and 1752.

Markree Catalogue of Ecliptic Stars.

3 vols. published, 5*s.* each.

Vol. I. containing 14,888 stars observed during the years 1848–50.
Vol. II. containing 15,298 stars observed during the years 1851–52.
Vol. III. containing 15,018 stars observed during the years 1852–54.

Markree Catalogue of Cometic Orbits.

Price 5*s.* to Subscribers; Non-subscribers, 7*s.*

Cometic Orbits, with copious Notes and Addenda. Compiled and edited by EDWARD J. COOPER. 1852.

Dove on the Distribution of Heat over the Globe. 12s.

With 9 Maps and Plates.

The Distribution of Heat over the surface of the Globe, illustrated by Isothermal, Thermic Isabnormal, and other Curves of Temperature. By H. W. DOVE.

[Sold only to Members of the British Association and Fellows of the Royal Society. The purchasers of the three first maps may, by returning them with a payment of Eight Shillings, receive the complete work in exchange.]

Philosophical Transactions of the Royal Society of London.

		£	*s.*	*d.*			£	*s.*	*d.*			£	*s.*	*d.*
1801.	Part I. ...	0	17	0	1820.	Part I. ...	0	15	0	1837.	Part II. ...	1	8	0
——	Part II. ...	0	17	6	——	Part II. ...	1	15	0	1838.	Part I. ...	0	13	0
1802.	Part I. ...	0	11	0	1821.	Part I. ...	1	4	0	——	Part II. ...	1	8	0
——	Part II. ...	0	17	6	——	Part II. ...	1	1	0	1839.	Part I. ...	0	18	0
1803.	Part I. ..	0	12	6	1822.	Part I. ...	2	0	0	——	Part II. ...	1	1	6
——	Part II. ...	0	13	6	——	Part II. ...	1	12	0	1840.	Part I. ...	0	18	0
1804.	Part I. ...	0	10	6	1823.	Part I. ...	1	12	0	——	Part II. ...	2	5	0
——	Part II. ...	0	12	6	——	Part II. ...	1	8	0	1841.	Part I. ...	0	10	0
1805.	Part I. ...	0	10	0	1824.	Part I. ...	0	12	6	——	Part II. ...	1	10	0
——	Part II. ...	0	11	6	——	Part II. ...	1	0	0	1842.	Part I. ...	0	16	0
1806.	Part I. ...	0	13	6	——	Part III. ...	1	4	0	——	Part II. ...	1	2	0
——	Part II. ...	0	17	6	1825.	Part I. ...	1	4	0	1843.	Part I. ...	0	10	0
1807.	Part I. ...	0	10	0	——	Part II. ...	2	0	0	——	Part II. ...	1	10	0
——	Part II. ...	0	15	6	1826.	Part I. ...	1	2	6	1844.	Part I. ...	0	10	0
1808.	Part I. ...	0	9	6	——	Part II. ...	0	12	6	——	Part II. ...	1	10	0
——	Part II. ...	0	14	6	——	Part III. ...	2	0	0	1845.	Part I. ...	0	16	0
1809.	Part I. ...	0	14	6	——	Part IV. ...	1	2	6	——	Part II. ...	1	0	0
——	Part II. ...	1	0	6	1827.	Part I. ...	0	18	0	1846.	Part I. ...	0	7	6
1810.	Part I. ...	0	10	6	——	Part II. ...	0	18	0	——	Part II. ...	1	12	0
——	Part II. ...	0	12	0	1828.	Part I. ...	1	1	0	——	Part III. ...	1	12	0
1811.	Part I. ...	0	15	0	——	Part II. ...	0	10	0	——	Part IV. ...	1	12	0
——	Part II. ...	0	15	0	1829.	Part I. ...	0	16	0	1847.	Part I. ...	0	14	0
1812.	Part I. ...	0	17	6	——	Part II. ...	0	14	0	——	Part II. ...	0	16	0
——	Part II. ...	0	17	6	——	Part III. ...	0	15	0	1848.	Part I. ...	1	0	0
1813.	Part I. ...	0	14	0	1830.	Part I. ...	1	10	0	——	Part II. ...	0	14	0
——	Part II. ...	0	18	0	——	Part II. ...	1	1	0	1849.	Part I. ...	1	0	0
1814.	Part I. ...	0	18	0	1831.	Part I. ...	1	10	0	——	Part II. ...	2	5	0
——	Part II. ...	1	4	0	——	Part II. ...	1	12	0	1850.	Part I. ...	1	10	0
1815.	Part I. ...	0	12	6	1832.	Part I. ...	1	1	0	——	Part II. ...	3	5	0
——	Part II. ...	1	2	0	——	Part II. ...	2	0	0	1851.	Part I. ...	2	10	0
1816.	Part I. ...	0	17	6	1833.	Part I. ...	1	1	0	——	Part II. ...	2	10	0
——	Part II. ...	0	17	6	——	Part II. ...	2	18	0	1852.	Part I. ...	1	0	0
1817.	Part I. ...	0	13	0	1834.	Part I. ...	0	17	0	——	Part II. ...	2	5	0
——	Part II. ...	1	2	6	——	Part II. ...	2	2	0	1853.	Part I. ...	0	18	0
1818.	Part I. ...	1	10	0	1835.	Part I. ...	1	2	0	——	Part II. ...	0	12	0
——	Part II. ...	1	0	0	——	Part II. ...	0	14	0	——	Part III. ...	1	2	0
1819.	Part I. ...	1	0	0	1836.	Part I. ...	1	10	0	1854.	Part I. ...	0	12	0
——	Part II. ...	1	5	0	——	Part II. ...	2	0	0	——	Part II. ...	0	16	0
——	Part III. ...	0	10	0	1837.	Part I. ...	1	8	0	1855.	Part I. ...	0	16	0

Journal of the Photographic Society.

Vol. I. 6*s.* cloth.

The Journal of the Photographic Society. Edited by Arthur Henfrey, F.R.S., F.L.S. &c. Price 5*d.*; Stamped 6*d.* Published on the 21st of every month.

Lithographic Signatures.—British Association.

To the Public 4*s.* To Members, 3*s.*

Lithographic Signatures of the Members of the British Association who met at Cambridge in 1833, with the Proceedings of the Public Meetings.

Indexes to the Philosophical Transactions.

Part I. being from commencement to the year 1780, 21*s.*
Part II. from 1781 to 1820, 12*s.*
Part III. from 1821 to 1830, 5*s.*

Abstracts of the Philosophical Transactions.

Abstracts of the papers printed in the Philosophical Transactions of the Royal Society of London, from 1800 to 1850 inclusive. Printed, by Order of the President and Council, from the Journal book of the Society.

Vol. I. 1800 to 1814. 7*s.* 6*d.*
Vol. II. 1815 to 1830. 7*s.* 6*d.*
Vol. III. 1830 to 1837. 7*s.* 6*d.*
Vol. IV. 1837 to 1843. 7*s.* 6*d.*
Vol. V. 1843 to 1850. 10*s.*
Vol. VI. 1850 to 1854. 6*s.*

Proceedings of the Royal Society. 5s. per annum.

These may be obtained on prepayment of an annual subscription of 5*s.*, which will include transmission by post to any part of the United Kingdom.

Royal Society Library Catalogues.

CATALOGUE of the SCIENTIFIC BOOKS in the Library of the Royal Society of London. 8vo. 15*s.*

CATALOGUE of MISCELLANEOUS LITERATURE in the Library of the Royal Society. 8vo. 2*s.* 6*d.*

OLD CATALOGUE of all the BOOKS in the Library of the Royal Society in 1825. 4to. 2*s.* 6*d.*

CATALOGUES of the MISCELLANEOUS MANUSCRIPTS and of the MANUSCRIPT LETTERS in the possession of the Royal Society. 8vo. 2*s.*

Catton's Astronomical Observations. 2s.

Astronomical Observations reduced and printed under the superintendence of G. B. Airy, Esq., Astronomer Royal.

Report of the Committee of Physics, etc. 1s.

Report of the Committee of Physics, including Meteorology, on the objects of Scientific Inquiry in those Sciences. Approved by the President and Council. 1840.

Sir H. Davy's Discourses. 3s.

Six Discourses delivered at the Anniversary Meetings of the Royal Society, on the award of the Royal and Copley Medals.

Meteorological Observations.

BLANK FORMS for CONTEMPORANEOUS METEOROLOGICAL OBSERVATIONS. Single sets, 1*s.*; or 25 sets, 20*s.* (Set, 2 large sheets.)

LARGE SHEETS for RECORDING METEOROLOGICAL OBSERVATIONS. 1*s.* each.

On the CORRECTIONS to be applied to the MONTHLY MEANS of METEOROLOGICAL OBSERVATIONS taken at any hour to convert them into mean monthly values. By James Glaisher, Esq., F.R.S. 6*d.*

University of London.

THE LONDON UNIVERSITY CALENDAR for 1844. 2*s.* For 1845 to 1855, 3*s.* each.

THE LONDON UNIVERSITY ALMANACK for 1846 to 1853. 1*s.* each.

Examination Papers.

MATRICULATION in the years 1838 to 1849. 1*s.* each.

BACHELOR of ARTS in the Years 1839 to 1848. 1*s.* each.

MASTER OF ARTS in the Years 1840 to 1849. 1*s.* each.

BACHELOR of LAWS in the Years 1839 to 1843. 1*s.* each. For 1847, 6*d.*

DOCTOR of LAWS in the Year 1843. 6*d.*

DOCTOR of LAWS and BACHELOR OF LAWS in the Years 1844, 1846 and 1848. 1*s.* each.

BACHELOR of MEDICINE in the Years 1839 to 1848. 1*s.* each.

BACHELOR of MEDICINE, First Examination in the Years 1839 to 1849. 6*d.* each.

BACHELOR of MEDICINE, Second Examination in the Years 1839 to 1848. 6*d.* each.

DOCTOR of MEDICINE in the Years 1839 to 1848. 6*d.* each.

Memoirs and Proceedings of the Chemical Society.

Vol. I. 1841 to 1843. 8*s.* cloth.
Vol. II. 1843 to 1845. 12*s.* cloth.
Vol. III. 1845 to 1848. 13*s.* 6*d.* cloth.

⁂ The parts comprising these volumes may be had separately.

Daubeny on Volcanos. 21s.

Second Edition. Greatly enlarged. With 12 Maps and Plates.

A Description of Active and Extinct Volcanos, of Earthquakes and of Thermal Springs. With Remarks on their Causes, Products, and influence on the condition of the Globe. By Professor CHARLES DAUBENY, M.D., F.R.S. &c.

Just published, Vol. III. with 4 plates.

Faraday's Experimental Researches in Electricity. 18s.

Containing Series 19 to 29 inclusive, and other Electrical papers from the Proceedings of the Royal Institution and Philosophical Magazine.

"Dr. Faraday has brought together his labours for the last ten years in the present volume. These embrace the experiments on the Magnetization of Light, Magnetic Polarity, the Discovery of Diamagnetism, and an examination of the Magnetic conditions of all matter; and in addition, several valuable argumentative papers on lines of magnetic force, on ray-vibrations, the nature of force, &c. The three volumes of 'Experimental Researches in Electricity' now published contain a series of remarkable investigations, which certainly offer the most striking evidence of the value of inductive philosophy that has ever been published in the English language."—*Athenæum*, June 16, 1855.

"The 'Experimental Researches in Electricity,' as presented in the present work, are among the most important and remarkable contributions to physical science of modern times."—*Literary Gazette*, April 28, 1855.

"To younger men devoted to physical science, this volume, like its predecessors, may be held up as one of the noblest examples which the records of knowledge affords to the spirit in which physical researches should be prosecuted and proclaimed."—*Edinburgh New Philosophical Journal*, July 1855.

Also Vol. I., *Second Edition.* 18*s*., with eight plates; and Vol. II., 9*s*., with five plates.

Morris's Catalogue of British Fossils. 12s.

Second Edition.

Comprising the Genera and Species hitherto described, with References to their Geological Distribution and to the localities in which they have been found. By JOHN MORRIS, F.G.S., Professor of Geology in University College, London.

Griffith on Urine. 3s.

With Two Plates.

Containing a Description of the General, Chemical and Microscopical Characters of the Urine and its Deposits, both in Health and Disease; with the best methods of separating and estimating their ingredients; also, a succinct account of the various concretions occasionally found in the body and forming Calculi. By JOHN WILLIAM GRIFFITH, M.D., F.L.S. &c.

Griffith on Blood. 5s.

With Two Plates.

Containing a Description of the General, Chemical and Microscopical Characters of the Fluids of the Body, viz. the Blood, Chyle, Lymph, Gastric Juice, Bile, &c.; also of the proximate principles which enter into their composition, both in Health and Disease, with the best methods of analysing them qualitatively as well as quantitatively. By JOHN WILLIAM GRIFFITH, M.D., F.L.S. &c.

Hopkins on the Connexion of Geology with Terrestrial Magnetism. 20s.

Third Edition. With 30 Plates and numerous Woodcuts.

On the Connexion of Geology with Terrestrial Magnetism; showing the general Polarity of Matter, the Meridional Structure of the Crystalline Rocks, their Transitions, Movements and Dislocations, including the Sedimentary Rocks, the laws regulating the Distribution of Metalliferous Formations, and other Terrestrial Phenomena. By EVAN HOPKINS, C.E., F.G.S.

The Illustrated Introduction to the above work may be had separately. Price 4*s*.

Gray's List of the Genera of Birds. 10s.

A List of the Genera of Birds, with their Synonyma; and an Indication of the Typical Species of each Genus: with an Appendix. By GEORGE ROBERT GRAY.

Wiegmann's Herpetologia Mexicana. £2.

A few Copies only on hand; with Coloured Plates.

Martin on the Geology of the Weald. 2s. 6d.

A Geological Memoir on the Anticlinal Line of the London and Hampshire Basins, and of the Weald. By PETER JOHN MARTIN.

Laming on Matter and Force. 4s.

With Five Plates.

Matter and Force, their Nature and Laws, analytically derived and synthetically applied; A New System, founded upon the Gravitation of Electricity, and proving the Universe to be sustained by a Moral Power: With an Essay on the Philosophy of Physical Science. By RICHARD LAMING.

Glaisher's Hygrometrical Tables. 2s. 6d.

Second Edition just ready.

Hygrometrical Tables, to be used with, and Description of the Dry- and Wet-bulb Thermometers. By JAMES GLAISHER, Esq., of the Royal Observatory, Greenwich.

Belville's Manual of the Mercurial and Aneroid Barometers. 1s. (*Second Edition.*)

Manual of the Mercurial and Aneroid Barometers. By John Henry Belville, of the Royal Observatory, Greenwich.

Belville's Manual of the Thermometer. 1s.

Manual of the Thermometer. By John Henry Belville, of the Royal Observatory, Greenwich.

Labels for Microscopic Objects. Sheet I. 1s.

Labels for the preparation of Microscopic Objects obtained from the Human Body.

Searle on the Tonic System. 6s.

A Treatise on the Tonic System of treating Affections of the Stomach and Brain. By Henry Searle, Surgeon.

Taylor's Calendar of the Meetings of the Scientific Bodies of London.

For 1854–55. Price 6*d*. Calendar for 1855–56 ready in November.

Meyen on the Progress of Vegetable Physiology. 3s.

A Report on the Progress of Vegetable Physiology during the Year 1837. By J. Meyen, M.D., Professor of Botany in the University of Berlin. Translated from the German by William Francis, Ph.D., F.L.S. &c.

Thorpe's Apollonius of Tyre. 6s.

The Anglo-Saxon Version of the Story of Apollonius of Tyre; on which is founded the Play of Pericles, ascribed to Shakespeare; with a Translation and Glossary. By Benjamin Thorpe, Esq., F.S.A. &c.

Thorpe's Anglo-Saxon Version of the Holy Gospels. 7s.

The Anglo-Saxon Version of the Holy Gospels, edited from the Original Manuscripts. By Benjamin Thorpe, Esq., F.S.A. &c.

Thorpe's Analecta Anglo-Saxonica. 8s.

Analecta Anglo-Saxonica. A Selection in Prose and Verse from Anglo-Saxon Authors of various ages: with a Glossary, designed chiefly as a first book for Students. A New Edition with corrections and improvements. By Benjamin Thorpe, Esq., F.S.A. &c. *Second Edition.*

Lappenberg's England under the Anglo-Saxon Kings. 12s.

A History of England, under the Anglo-Saxon Kings, translated from the German of Dr. J. M. Lappenberg, For. F.S.A., by Benjamin Thorpe, Esq. F.S.A. &c, with additions and corrections by the Author and Translator. 2 vols. 8vo.

The Philosophical Magazine.—(Fourth Series.)

The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science; a Journal devoted to Physics, Astronomy, Mechanics, Chemistry, Mineralogy, and the allied Sciences.—In Monthly Numbers, Price 2*s.* 6*d.*

Conducted by
Sir DAVID BREWSTER, K.H. LL.D. F.R.S. L. & E. &c.;
RICHARD TAYLOR, F.S.A. L.S. G.S. Astr. S. &c.;
Sir ROBERT KANE, M.D. F.R.S. M.R.I.A. &c.;
WILLIAM FRANCIS, Ph.D. F.L.S. F.R.A.S. F.C.S.;
JOHN TYNDALL, Ph.D. F.R.S. &c.

The first Series, in sixty-eight volumes, the Second Series, in eleven volumes, and the Third Series, in thirty-seven volumes,—being from the year 1798 to 1850,—may be had separately at reduced prices.

The Annals of Natural History.—(New Series.)

The Annals and Magazine of Natural History; including Zoology, Botany, and Geology. Being a Continuation of the 'Annals' combined with Messrs. Loudon and Charlesworth's 'Magazine of Natural History.'—In Monthly Numbers, price 2*s.* 6*d.*

Conducted by
P. J. SELBY, Esq., F.L.S.—Dr. JOHNSTON;
CHARLES C. BABINGTON, Esq., M.A. F.R.S. L.S. G.S.;
Dr. BALFOUR, Prof. Bot. Edinb.; and RICHARD TAYLOR, F.L.S. G.S.

The First Series may be had at a reduced price, viz:—Vols. I. to X. £3 5*s.* Vols. XI. to XX., £3 5*s.* The First Series, complete in Twenty Volumes, for £6. The Second Series, Vols. I. to X., £5 10*s.* Or a Complete Set from commencement of the work to December 1852 (Thirty Volumes), for £10 10*s.*

The Scientific Memoirs.

Scientific Memoirs, selected from the Transactions of Foreign Academies of Science, and from Foreign Journals.

The **First Series**, price 6*s.* each part; or a complete set in 21 parts, forming 5 volumes, for £4 4*s.*

The **Second Series**, in Two Divisions, price 3*s.* each part, viz.:—

Natural Philosophy; edited by JOHN TYNDALL, Ph.D., F.R.S., and WILLIAM FRANCIS, Ph.D., F.R.A.S., F.L.S.

Natural History; edited by ARTHUR HENFREY, F.R.S., F.L.S., and THOMAS HENRY HUXLEY, F.R.S.

The Chemical Gazette.

The Chemical Gazette; or Journal of Practical Chemistry, in all its applications to Pharmacy, Arts and Manufactures. On the 1st and 15th of each Month, price Sixpence (*Stamped, Sevenpence*).

Conducted by
WILLIAM FRANCIS, Ph.D. F.L.S. F.R.A.S. F.C.S.

Eleven volumes published. Vol. I. 14*s.*; Vols. II. to XII., 12*s.* each.

3 2044 103 126 280

Date Due

~~APR 2? 1984~~